Demonstrating greater sustainability while maintaining desirability of plush dog toys through life cycle assessments and dog owner participation

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This project could not be completed without the help of my entire committee and my advisor, Kevin Shankwiler.

Kevin: Thank you so much for working with me through ALL of my questions, helping me to remain focused and on track, encouraging me throughout the entire process (the highs and the lows), and being there throughout all of the tears, the laughs, the freak-out moments, and all of the above.

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Richard: Thank you for your utmost enthusiasm and excitement for the project and for believing in me to make something great.

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INTRODUCTION

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Every year, an estimated 634 million dog toys end up in our landfills, which is equivalent to 40,500 tons of waste. These numbers are a result of planned obsolescence due to their short life cycles. Pet businesses induce consumerism by offering dog toys with a limited useful life and therefore creating repeat purchases. Which then leads to millions of toys ending up in landfills every year. This book details the design of a dog plush toy that aims to divert millions of dog toys from the landfill while also decreasing their environmental impact through a life cycle assessment. Additionally, understanding what motivates consumer behavior and how to bring about change was thus seen as key to efforts and strategies to promote more sustainable patterns of consumption of dog plush toys.

The project answers the following question: through the lens of a life cycle assessment (LCA), is it possible to design a sustainable dog toy that dog owners are willing to buy? Information gathered from a literature review and several interviews with experts in both the pet and sustainability industry were conducted to understand the problem space in three key areas:

- current pet industry market
- current sustainability market
- target demographic and their habits and desires

From here, the ethnographic research below helped to understand dog owner's desires and purchasing habits in the forms of:

- 1 online survey completed by 300+ dog owners
- 8 online interviews
- 6 exploratory visits to dog toy stores

This research highlighted that plush squeaker dog toys were the favorite amongst dogs and dog owners. This insight led to an initial LCA calculation using Okala Impact Factors to establish a baseline of their current environmental impacts and an overall understanding of their entire product life cycles. The calculation revealed a significant finding that the extraction of the raw materials in the design of dog plush toys had the highest environmental impact.

After collecting all the data, affinity and systems mapping were then used to develop the design criteria. One insight came through regarding the usage of a single material. If a dog toy consists only of a single material, it minimizes raw material extraction. Therefore, requiring no disassembly and consequently being easily recyclable. This insight was an important aspect of the design. Many rounds of concept development and ideation got conducted as new insights and information came regarding the recyclability of dog toys. To minimize the materials collected for manufacturing inspiration came from a previous design project. The project used upcycled t-shirts to create a braided rope dog tug toy. Instead of using the t-shirts as rope, an idea came to use them as stuffing for the toy. Which consequently included the added benefits of reducing separation anxiety in dogs from several articles found online.

This idea had several challenges associated with the durability, safety, and recyclability of the dog toy. After several rounds of testing to assess and mitigate these issues, one final concept got narrowed down after meeting the following: solution viability, all design criteria, and all three needs of desirability, profitability, and sustainability. The final prototype came to be a dog plush squeaker toy. It flips inside out to reveal a printed business reply mail label and, therefore, can easily be placed in the mailbox to send to a textile recycling facility.

The final prototype was tested and evaluated with seven female millennial dog owners (to match the target demographic) to understand levels of desirability and suggestions for improvement. Once the feedback was collected and addressed into the final design, an LCA calculated and determined its overall environmental impact versus a standard plush toy found at current pet stores. The calculation showed that the new design had a significantly lesser impact. Also, 100% of dog owners stated they would be willing to purchase the dog toy in the evaluation assessment. Therefore, meeting the needs of desirability. In conclusion, it is possible to design a sustainable plush dog toy that dog owners are willing to buy.

GOALS OF THE STUDY

This thesis project aims to answer the following questions:

1. How might we design and develop a dog toy that has a lower environmental impact through a life cycle assessment (LCA)?

2. How might we design and develop a sustainable dog toy that dog owners are willing to buy?

The overall goal of this study is to develop a dog toy that has a lower environmental impact calculated from an LCA versus a standard or baseline toy in the current market today. I also hope to accomplish a design that creates a balance of all stakeholders involved to meet desirability, profitability, and sustainability to develop a toy that owners are willing to buy.

To accomplish this, I acquired experts both in the sustainability field and in the pet industry to be on my committee: Richard Braunstein and Jeff Watson, respectively. Jeff is currently the Director of Product Engineering at PetSmart. He also has a background in Industrial Design and exhibition and interaction design. Richard is currently an adjunct faculty member at the Georgia Institute of Technology and also holds a Masters in Industrial Design. He currently teaches Materials I that examines the characteristics, production technologies, histories, and environmental impacts of nine categories of renewable materials familiar to industrial design. This course also includes teaching the class how to use LCA software such as Gabi and openLCA. Additionally, I took it upon myself to take a Life Cycle Assessment (LCA) course in the Fall of 2020 under the school of ISYE (Industrial & Systems Engineering). This course helped build my knowledge of conducting LCA's and understanding life cycle assessments and calculations in general.

OVERVIEW

DESIGN METHODOLOGY

The structure of this study followed the double-diamond technique: Discover, Define, Develop, Deliver. This method allowed me to dive into user research to define the problem. Then to conduct studies to test and learn about potential concepts to find the best solution.

DISCOVER

The discover phase consisted of the following:
1. Ethnographic research: online surveys and interviews, general conversations with experts in the field, exploratory visits to pet stores
2. General research of dog market: ownership, dog toys, sustainable solutions, choice of materials, etc.
3. General research and participation in sustainability courses (IDSA conferences, LCA class)
4. Calculations and life cycle assessments of dog toys in the current market using Okala Impact Factors
5. Insights from mood board development

DEFINE

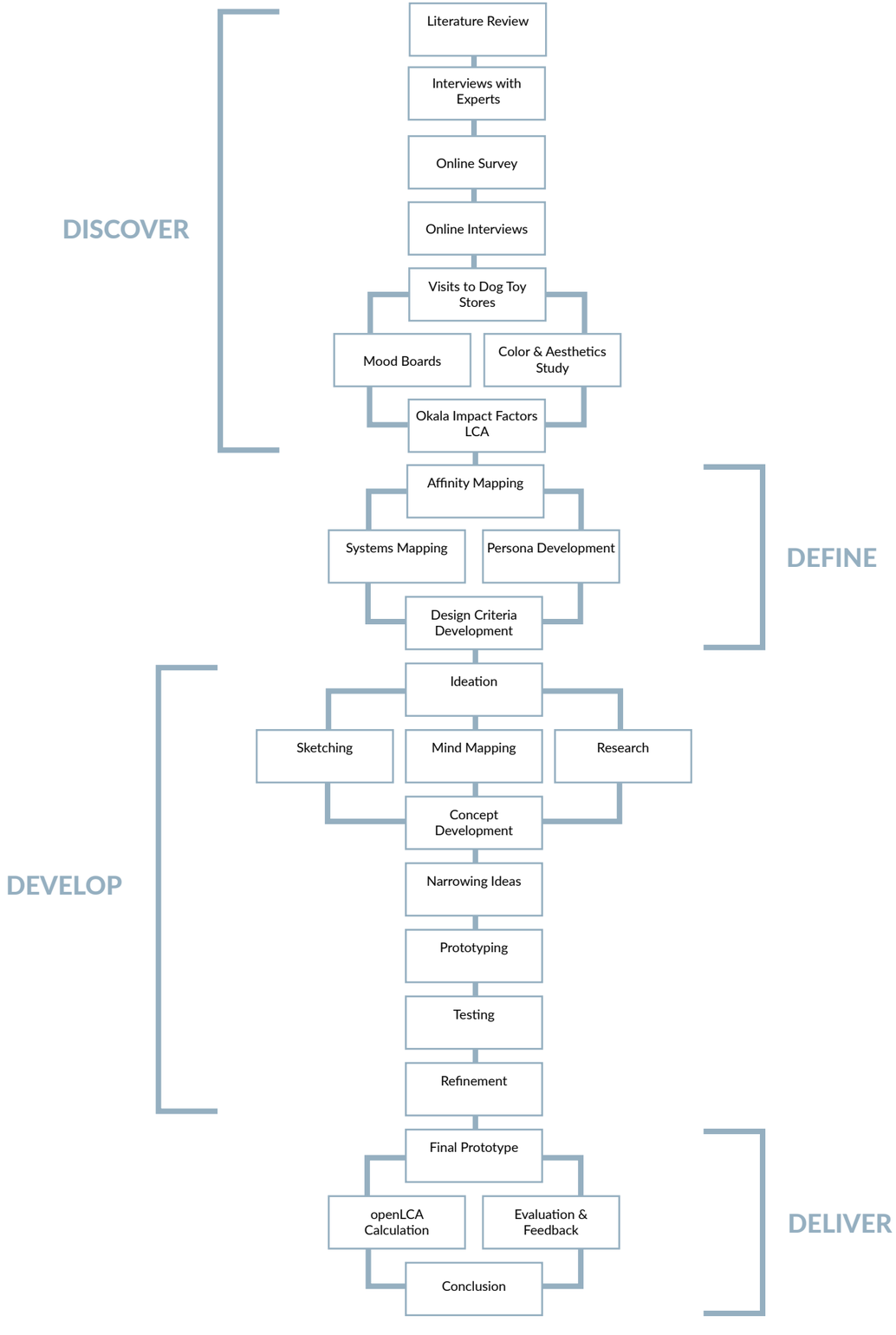
After combing all of my data, I was able to target dog toys specifically to begin developing design criteria. Affinity mapping and systems mapping techniques then developed the personas of the target audience.

DEVELOP

For someone who has never worked with soft goods design and did not know how to use a sewing machine - this part was a challenge for me. After many hours of trial and error and watching several hours of YouTube tutorials, I felt that my skills provided sufficient enough to develop a “works-like” prototype. From there, I was able to narrow down my concept ideas to test with dog owners for their feedback and considerations for improvement.

DELIVER

Concepts were prototyped and tested with dog owners in their own homes. Following their feedback, the final design got created. Using openLCA, the life cycle assessment software, then calculated if my dog toy had a lesser environmental impact than the baseline dog plush toy.



BACKGROUND

PROJECT BACKGROUND

Little to no research has shown the reasoning as to why dog owners are constantly upset with the quality and value of their dog's toys. Large retail stores like PetSmart sell various pet items ranging from toys, bedding, bowls, carriers, collars, leashes, furniture, and more. Dog toys, however, are continuing to see steady growth. They are one of the faster-growing segments in the pet toy category. In 2016, dogs accounted for 75% of pet toy sales, which passed $1B in the United States, up from $851 million in 2011 (DeLuca, 2018). Online reviews of dog toys are given an overall score from 1 to 5 based upon three categories: quality, value, and pet satisfaction. Out of every review category, the most consistent and passionate 1-star rating is towards quality and durability. After introducing the newly purchased item, dog owners state it had ripped or been chewed up and destroyed in a matter of days or even hours. Therefore, needing to discard the recent purchase and replace it with a new one. This constant cycle of dog owners needing to replace newly bought dog toys alludes to the possibility of planned obsolescence within the pet industry.

Planned obsolescence (PO) is a strategy in industrial design to plan or design a product with a limited useful life. So it will then become obsolete, unfashionable, or no longer functional after a certain period (Rivera & Lallmahomed, 2016). The term was initially coined in the United States in the late 1920s based upon a business strategy of creating goods with a limited lifetime. This strategy ultimately led to the mass consumption of goods in a time of economic crisis (Rivera & Lallmahomed, 2016). An extensive body of literature argues for the benefits of PO, the strategy of designing products with low durability to induce repeat purchases from the consumers and allow the firm to sell a larger volume at a lower price (Agrawal, Kavadias, & Toktay, 2016). On one side, consumers only see the benefit of decreased price, but when combined with a short life is the ideal scenario for businesses to exploit PO (Rivera & Lallmahomed, 2016).

Based upon pet industry leader websites, like PetSmart and Petco, their toys can range anywhere in price between $0.79 to $200. The higher-end being more technologically advanced, and the lower end being smaller, non-technical items, like tennis balls. On average, however, dog toys typically fall in the $5 range. These are made from latex, rubber, soft fabrics, and a variety of other materials. With dog owners spending about $48 per year on toys alone ("Pet Industry Market Size & Ownership Statistics," 2020), that is equivalent to about 10 toys per year that end up in our landfills. It may seem small, but with dog ownership continuing to rise, reaching 63.4 million in 2020, that number then becomes 634 million toys in our landfills each year ("Pet Industry Market Size & Ownership Statistics" 2020).

Dog owners have come to accept what a 'normal' lifespan is for these items. PO has been indiscriminately practiced in the camouflaged form right up to the present day through these so-called durable products (Pope, 2017) in the pet industry. Due to the high volume of negative product reviews of durability and having to throw away and replace their toys within a few days, it seems that PO is evident. This strategy not only affects consumers and businesses but also affects the environment. Products with shorter lifespans produce more waste which in many circumstances ends up in landfills (Rivera & Lallmahomed, 2016). PO is an unsustainable strategy because it is part of an unsustainable economic and development model and needs to be solved (Pope, 2017).

Planned obsolescence represents a real challenge for designers and engineers as this practice generates more environmental impacts than it should. In 2017, the total generation of municipal solid waste (MSW) was 267.8 million tons, approximately 5.7 million tons more than in 2015 ("National Overview: Facts and Figures on Materials, Wastes, and Recycling," 2020). Its practice has socio-environmental consequences that support the continuity of consumerism because it puts the continuity of human life on earth at risk (Pope, 2017). Therefore, understanding what motivates consumer behavior will help to promote more sustainable patterns of consumption.

By analyzing customer spending habits, PetSmart found that consumers are willing to buy more sustainable items at a higher price point until the point of purchase at the register. Here, consumers then realize the product isn't worth it and would buy the cheaper item instead. The big question then becomes: what factors in product design will drive consumer purchases toward a sustainable toy design, rather than a cost comparison?

Millennials today seek to be a part of worthy causes and care about a brand's impact on people and the environment. Although it is technically possible to design more durable products, economic, institutional, and psychological factors prevent their success. Therefore, a more structured and systematic approach is required (Genus, 2016). Businesses that implement and recognize these strategies could reap more benefits through this type of sustainable design. Sustainable design optimizes the needs of people and the planet with the desire for innovation, aesthetics, and corporate profits (Montague, 2016). There is an evident increasing need for the pet industry to incorporate these practices. Today, businesses that invest in sustainable design are reaping higher revenue and profits and recruiting more employees. A study recorded that 35% of workers would take a pay cut to work for a company committed to social responsibility (Montague, 2016). Whereas, in an interview conducted by PSC of 250 pet industry members, they reported that 36% of the professionals surveyed said that their company doesn't have a sustainability program at all (Martin, 2018). However, for those that do have a sustainability program, only 23% would call it 'effective' or 'very effective' (Martin, 2018). There is plenty of room for improvement in the pet industry to adopt sustainable practices. These have never been more critical than today, and pet industry professionals are falling behind, especially when it comes to planned obsolescence in dog toys.

To help understand where a dog toy's highest environmental impact lies in its product lifecycle. A complete life cycle analysis consists of five phases: raw material extraction, manufacturing and processing, transportation, usage and retail, and waste disposal. Also known as cradle to grave. Cradle being the inception of the product with the sourcing of the raw materials, grave being the disposal of the product (Liebsch, 2021). Once this is complete, then a full Life Cycle Assessment (LCA) can be calculated. A Life Cycle Assessment (LCA) is a primary tool to support decision-making for sustainable product development. An LCA can benefit product research and development, supply chain and procurement, marketing and sales, and executive-level and strategic management. According to the United States Environmental Protection Agency (USEPA), an LCA is a tool to evaluate the potential environmental impacts of products, materials, processes, or activities. The phases of a Life Cycle Assessment are defined in the ISO standards 14040 and 14044 and consist of four steps: definition of goal and scope, inventory analysis, impact assessment, and interpretation. First, the system and functional unit are defined, as well as the limits of the analysis. Then, in the inventory analysis, everything that flows in and out of the system is measured. The goal is to quantify the inputs and outputs. Next, a process flow diagram gets created that clearly shows the system and units getting analyzed (the inputs and outputs). Once the impact assessment gets completed, it gets defined in terms of impact categories. Impact categories are how you want to measure your product's impact. For example, you might want to measure the impact of your products on climate change in CO_2-equivalent. Some impact categories get measured in equivalents, often seen as a lowercase e, for example, CO_2-e

PROJECT BACKGROUND

for CO_2-equivalent because several emissions contribute to the same impact category. For example, climate change or global warming potential (GWP) get measured in CO_2-equivalents. But this doesn't mean that only CO_2 is contributing to global warming because, for example, methane and nitrous oxide also plays a role there. But to consolidate all gases into one indicator, all other gases are transposed into CO_2 equivalents (Liebsch, 2021). Finally, after interpreting the data, conclusions are drawn. These get done by assessing how high the emissions are of the product and how it compares to similar products. Additionally, understanding the leverages to reduce the impact of the product and how to be more efficient in manufacturing.

Through the lens of an LCA, little to no research has been performed on pet products or dog toys specifically. The performance of an LCA will help determine where a dog toy can improve in terms of sustainability and its overall environmental impact. In reality, being more sustainable can mean using less energy, recycle materials or streamline processes. All actions that can save high amounts of money, immediately increase the bottom line, and make a company less dependent. By making this more aware to consumers, they can be more confident in their purchasing decisions and hopefully mitigate planned obsolescence in the pet industry.

Consumers are increasingly concerned about the negative impacts that their purchasing decisions have on the planet. This study aims to provide more information regarding dog toys, sustainability, and the environmental impacts conducted through a life cycle assessment. It will show more insights into dog owner's purchasing habits. Therefore, revealing gaps where a new dog toy could get designed and implemented to help improve its environmental impact through thoughtful design.

INSIGHTS FROM LITERATURE REVIEW

Dog toys, on average, cost $5. Annually, dog owners spend about $48 on toys which equals to about 10 dog toys per year that end up in our landfills. When multiplied by the number of dogs owned in 2020 (63.4 million), 10 toys quickly become 634 million toys that end up in our landfills. Additionally, the average weight of a dog toy is about 58g, which then totals 36.7 million kg of waste produced. With these types of staggering numbers, it is surprising to see no current research on the environmental impact of dog toys due to their short lifespans, the number of toys purchased per year ending up in landfills, and increasing numbers of dog ownership.

634 MILLION

dog toys ends up in our landfills every year

36.7 MILLION

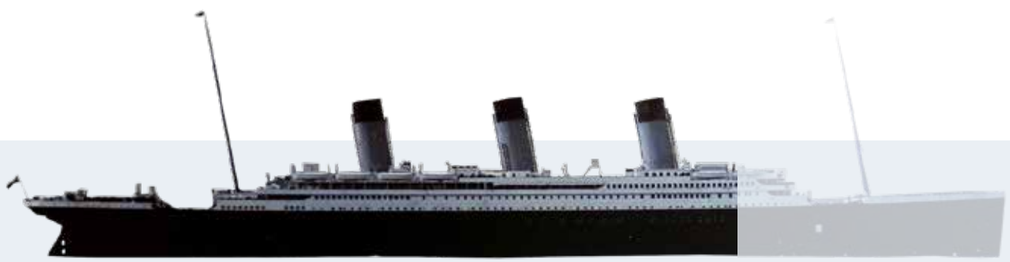
kilograms of waste produced

ESTIMATED COMPARISONS

To put this into perspective, the largest international airport located in Atlanta, GA covers about 2.5 million square feet. It can be estimated that the average dog toy measures around 15 square inches. When converted into square feet, the amount of dog toys ending up in our landfills every year is equivalent to about 26 Hartsfield - Jackson Atlanta Airports. Additionally, the waste from dog toys equals about 77% of the weight of the Titanic, about 53, 210 tons.

x26

HARTSFIELD - JACKSON ATLANTA AIRPORTS



77%

WEIGHT OF TITANIC

DISCOVER

SUSTAINABILITY EXPERTS

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BFA Industrial & Product Design
MSc Sustainability, Entrepreneurship & Design, Sustainability Studies

IDSA Conferences

Event 1: Sustainability Deep Dive
Event 2: Design Voices: Circular Business Model “Close That Loop!”

Only 9% of the world’s plastic is recycled today

We need more investment in the infrastructure to make recycling a more profitable business idea

Consequences of decisions made at design stage account for 80% of environmental impacts

Extraction of raw materials have the biggest impact from LCA

Recycling is not the ultimate solution

Reduce manufacturing waste

Circular economy > linear economy

Design for second life

Product systems and/or services

Focus on benefits user will receive

Consider entire product life-cycle

People do not understand language of sustainability

Design for disassembly

Balance desirability, profitability, sustainability

Foster emotional connection to product

PET INDUSTRY EXPERTS

DESIGNERS & ENGINEERS

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Senior Product Design Manager

Katie Lim
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MANUFACTURERS

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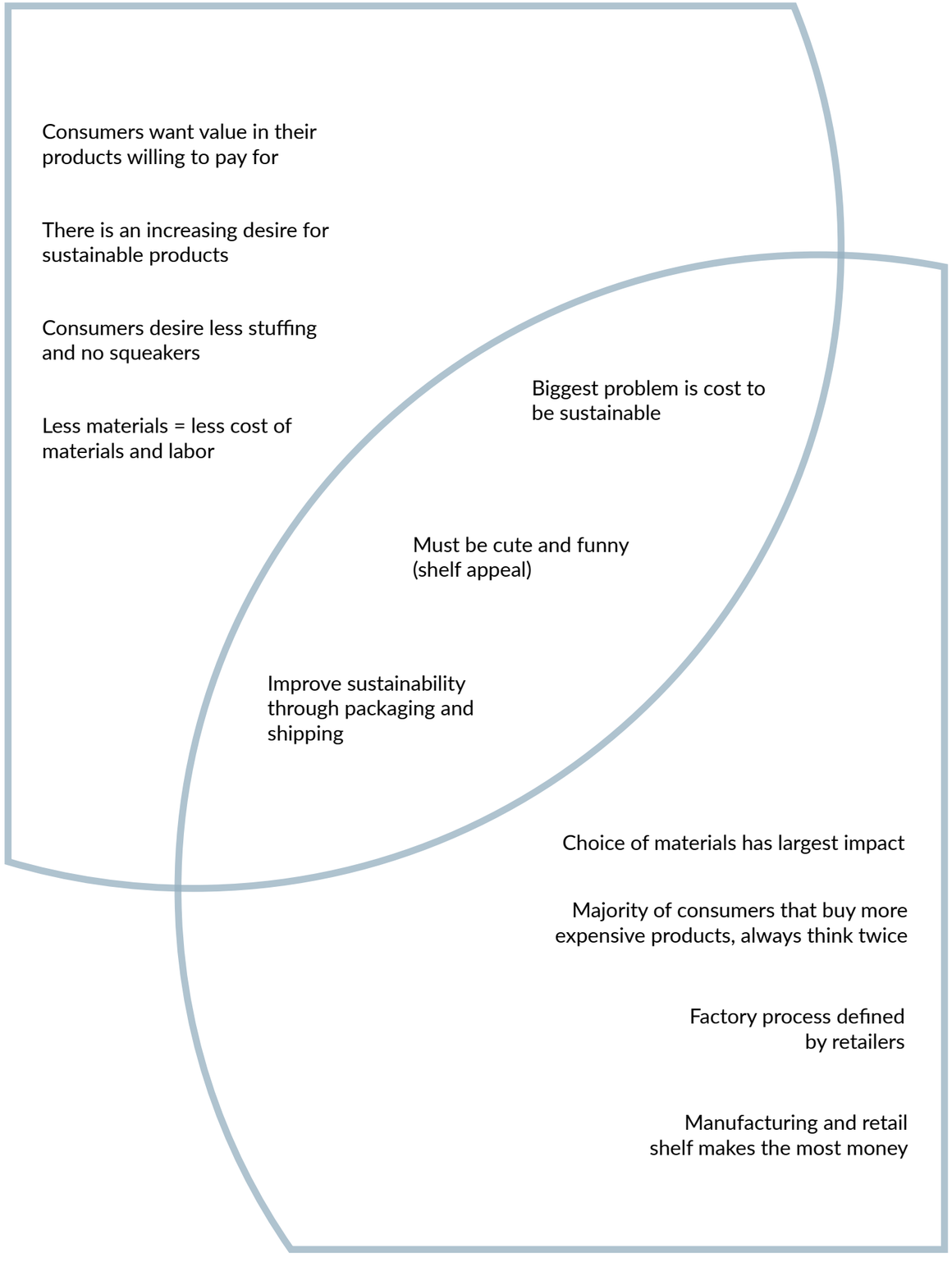


SUMMARY OF FINDINGS

DESIGN FOR CIRCULAR ECONOMY

- Eliminate waste and pollution
- Keep products and materials in use
- Regenerate natural systems
- Balance desirability, profitability, sustainability
- Consider entire product lifecycle

RECYCLING NOT THE SOLUTION

- Recycled materials decrease overall quality and generally have a lower demand, which makes it more expensive to acquire
- Emphasize long term use > recycling
- Recycling validates waste
- Design for fast manual or automated disassembly
- Design better recycling business model

THINK SYSTEMS

- Materials are not enough, sustainable materials does not necessarily mean sustainable design
- Take back system
- Product as a service
- Design up-gradable products
- Design for second life with different function
- Provide for reuse of components
- Integrate methods for use product collection

IMPROVE USER EXPERIENCE

- Zoom into the user's needs
- People do NOT understand language of sustainability
- Cannot design behaviors
- Eliminate pain points of ownership
- Foster emotional connection to product
- Focus on the benefits the user will receive
- Durable and timeless products = consumer loyalty
- Design for maintenance and easy repair

SUMMARY OF FINDINGS

DESIGN FOR DOG

- Upcoming trends: something that occupies and calms them, safety, natural materials, toys that will help dogs as their owners go back to work
- Safety: recycled materials can contain toxins and/or contaminants
- Polyester is the most durable material
- Mentally stimulating and fun (squeakers, etc.)

AREAS FOR SUSTAINABLE DESIGN

- Better material choices
- Nesting more products into single shipping crate
- Decrease weights
- Alternate methods of shipping
- Alternate inks, laminate, and strings in packaging system

DESIGN FOR DOG OWNER

- Biggest complaints "need to be tougher"
- Cuteness and funny factor plays a HUGE role (too serious = no appeal)
- Needs an immediate emotional connection
- Target/focus is on the millennial female dog owner
- Timelines vary with how long a toy is considered "durable"
- Consumer defines sustainability by a product that performs
- Sales are driven by consumers perception (see, touch, feel, etc)
- Solves a consumer problem or need

COST BIGGEST FACTOR

- It is expensive (and difficult) to receive certification labels for truly recycled and/or sustainable products
- Recycled materials come at a higher cost than virgin materials
- Cut and sew toys are purely impacted by raw materials because majority of the work is done by hand, rather than by machines
- Extraction and choice of raw materials biggest impact in cost
- Manufacturing and raw material cost 1:1 ratio
- Push for cost neutrality

ONLINE SURVEY

After getting a general understanding of the pet product industry and aspects of sustainability, I desired to understand dog owners' perception of sustainability and desirability in terms of non-food-related pet products. Therefore, I decided to conduct an online survey, and after just one week, I received over 300 responses. I realized quickly that this market is easily accessible and widespread, especially since dogs are becoming more important in people's lives and get treated like family. From the survey, I realized three main aspects of dog owners: First, they are increasingly aware of their habits and purchasing decisions that impact the environment. Second, the demographic consists of white millennial females. Third, when it comes to purchases of non-food-related products for their dog, it must be within a similar price range as other competitors. Especially so when the product gets labeled as sustainable. Overall, dog owners must understand if their dog will like the product and be

300+ RESPONSES

PURCHASING INFLUENCES

60% Will my dog like it?

41% Safety

34% Durability

68% Prefer sustainable options within same price range

SUSTAINABILITY

78% Believe it is important to minimize impact on environment

70% More likely to purchase a product with a green label

46% Believe sustainability is important with non food-related pet products

DEMOGRAPHICS

75% Female

83% White

54% Millennial

69% Owns 1 dog

77% 0 Children (in household)

ONLINE INTERVIEWS

Online interviews got conducted to gain more detailed information regarding dog owners purchasing decisions and habits with those who volunteered to participate in future studies from the online survey. A total of 8 dog owners got interviewed. There were four main takeaways from the interviews. One, owners defined sustainability by durability and the ability to recycle something. Two, eco-friendly or sustainable dog toys are unheard of or 'unseen.' Three, owners desire transparency and clear communication. Lastly, stuffed squeaker toys are almost every dog's favorite. Also, 3/8 dog owners mentioned they wish the dog toy to be recyclable and that their dog has separation anxiety.

It is interesting to discover that some owners know stuffed squeaker toys will be destroyed quickly (or a waste of money) but still buy them regardless. The positive aspects of the toy outweigh the negative.

The owner is aware they will be wasting $5 on a toy for only a few minutes or hours of play with the toy. However, they still buy it because it is cute, and they know their dog will love it. It was at this point where I began to focus on designing for a plush squeaker dog toy.

7/8

Stuffed squeaker toys are their dog's favorite

Desire cuteness, durability, and good price points

8/8

Throw away their dog toys after it's destroyed

Have never seen a sustainable dog toy before

WHERE THEY SHOP

Dog owners typically avoid big box pet stores due to their higher prices. They might go to a PetSmart or Petco to buy their dog's food, but anything else, they are more likely to purchase it at a store where they do their typical shopping. It is more convenient for them to buy what they need (groceries, clothes, etc.) at a store like TJ Maxx and then decide to walk down the toy aisle to surprise their dog when they get home. Dog owners are also more likely to shop in-store for dog toys for the tactile experience. They can touch and interact with its features before purchase to determine if their dog would like it or not.

THOUGHTS ON SUSTAINABILITY

When asked about sustainability, dog owners typically responded positively. Current dog owners desire to implement more sustainable practices into their daily lives and help make a difference. Some noted it would make them feel better about themselves.

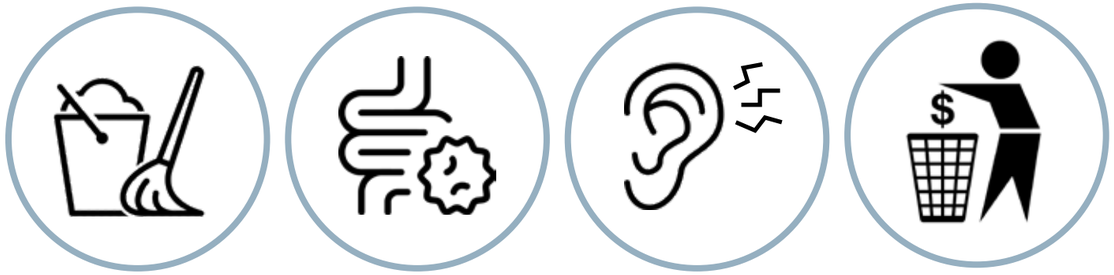
When it comes to purchasing sustainable products, the first item brought up was the price. Dog owners are willing to pay more for a sustainable item only if it is within a few dollars more of similar products. Also, it should be significantly different from its non-sustainable alternatives. Dog owners do not want to pay more for an item when "it looks like everything else" on the shelves. The second item brought up was durability. Several dog owners noted that if it is sustainable, it should be durable.

The only negative thing dog owners discussed was the lack of information on products labeled or marketed as sustainable. The labels are hard to find (too small), and there is little information on the packaging explaining its contents or how it gets produced. Dog owners desire transparency. Therefore, it leads to a lack of trust in the overall product itself if not properly communicated.

WHY PLUSH TOYS?

Dog plush toys are the number one seller in terms of the number of units sold per year. According to PetSmart, the leading pet retailer, they sell about 3 million plush toys per year. Therefore, a sustainably designed plush toy would have the biggest impact on the market. So what makes them so popular amongst dogs and dog owners? Even though there are a variety of negative aspects (see below), dog owners perceived value outweighs the negative especially when they know they are spending their money on something they know their dog will enjoy. The cuteness factor also plays a huge role in “impulse buys”. If it catches their attention and they are confident their dog will like it, they will most likely purchase it, sometimes even outside their price range if it is unique enough.

NEGATIVE ASPECTS



Cleaning up mess (stuffing, shreds)

Ingestion hazards

Annoying squeaker sounds

Throwing away money (short lifetime)

POSITIVE ASPECTS

Plentiful and widely available

Low cost

Dogs and owners enjoy the experience

Cute and funny aesthetics

VISITS TO DOG TOY STORES

After understanding where dog owners typically shop, I decided to visit each store to understand key areas of retail design: shelf layout, marketing techniques, and the variety of toys offered. This would allow me to find major trends or differences amongst the stores. After visiting 6 stores (PetSmart, Petco, TJ Maxx, Target, Walmart, Homegoods), I found four major groups: eco-friendly/natural toys, durable/tough toys, packaging and marketing techniques, and other (toys).

When comparing major pet retail stores to non-pet retail stores (but still offer dog toys), the major differences were price, organization, and a variety of more toys offered. PetSmart and Petco have strategically designed their store to categorize toys by size, durability, style of play, and more. They offer a wider selection, but they also come at a slightly higher price than general retail stores. Retail stores, like Walmart and Homegoods, did not have a specific layout for their toys. It was much more randomized and usually only offered one of each toy. It was a very similar experience to shopping at a thrift store - you will only find one of them in a pile of many other clothes but at a great price. Also, I noticed how important it is to have shelf appeal. Customers would randomly stop at toys that caught their attention and touch and squeak different toys to “test” them.

I then decided to do a quick color study by using the eyedropper tool to find what colors are used for specific strategies in dog toy design. This would help me understand what colors the current market uses when designing for durability, sustainability, marketability (eye-catching tags/colors, popularity, etc.), and the other general selection of toys. This information would allow me to design a toy to either be able to stand out from the crowd or help owners effectively understand where this product belongs visually.

ECO-FRIENDLY AND/OR NATURAL

PACKAGING/MARKETING

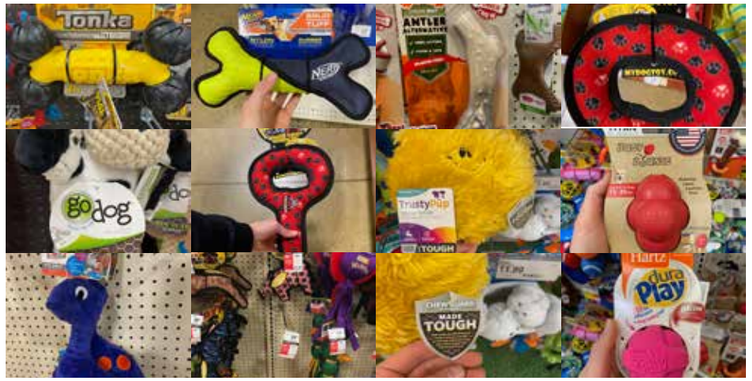
DURABLE/TOUGH

OTHER

From this collection, bright and bold colored tags are placed on the toys to grab your attention on specific features of the toys (squeakers, durability, etc.). Eco-friendly/natural toys use very earthy tones like light browns, oranges, and greens. Durable/tough toys and the other general collection of toys interestingly use a similar mix of darker tones of warm and cool colors. As a consensus, dog toy color schemes typically include shades of green, orange, red, and blue.

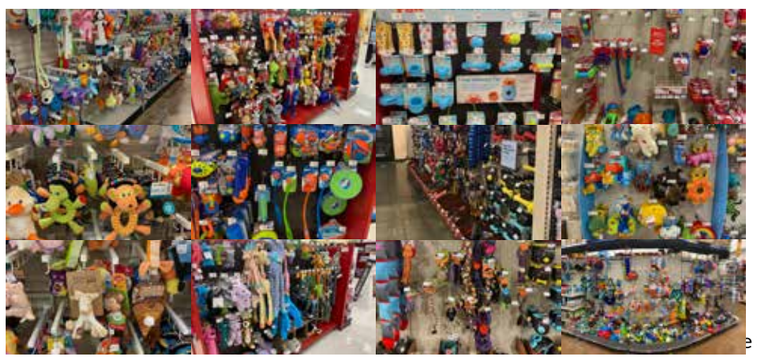
MARKETING

DURABLE TOYS



NATURAL TOYS

OTHER TOYS



MOOD BOARDS

I then decided to do several mood boards to collect and gather more themes across multiple categories. From my previous online surveys and interviews, dog owners desired cute, durable, and safe toys; however, I wondered why sustainable toys were not “seen” or not desirable. Also, I wanted to understand what defined durable and cute in dog toys. Therefore, I looked at trending characters, color schemes, packaging design, durable products, and baby products in multiple product categories other than dog toys to compare. Below are the findings.

CHARACTER/TOY TRENDS

Animal based (squirrels, foxes, etc.)

Unboxing/surprises inside

Hide n’ seek

TV show and movie based characters

SAFE

Green color palette

“Safe” verbiage and symbols

More information included

CUTE

Soft smiles

Simple and/or expressive faces

Non-proportional features relative to body

Large or small spacing between facial features

Fun color palette (pastels, bright colors, etc.)

BABY

Animal based

Characterized and ironic packaging

Bright color palette (primary colors)

Light color palette (pastels)

DURABLE

Big bold text

Strong-like animals (rhinos, bears, etc.)

Capital letters in branding

“Strong” verbiage and symbols

Dark color palette (blues, browns, dark green, etc.)

SUSTAINABLE

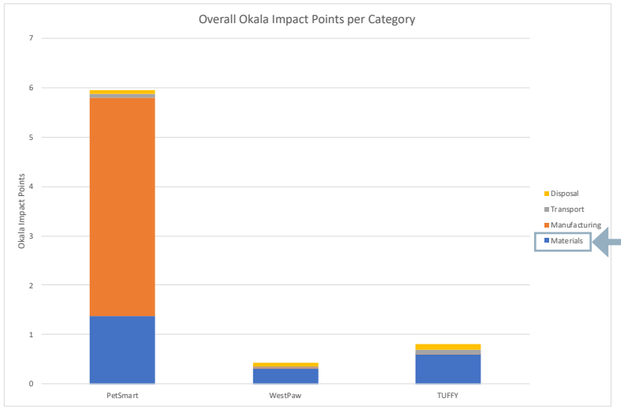
Earthy color palette (browns, greens, etc.)

“Handmade” aesthetic

Smaller and flatter shapes (less round)

INITIAL LCA CALCULATION

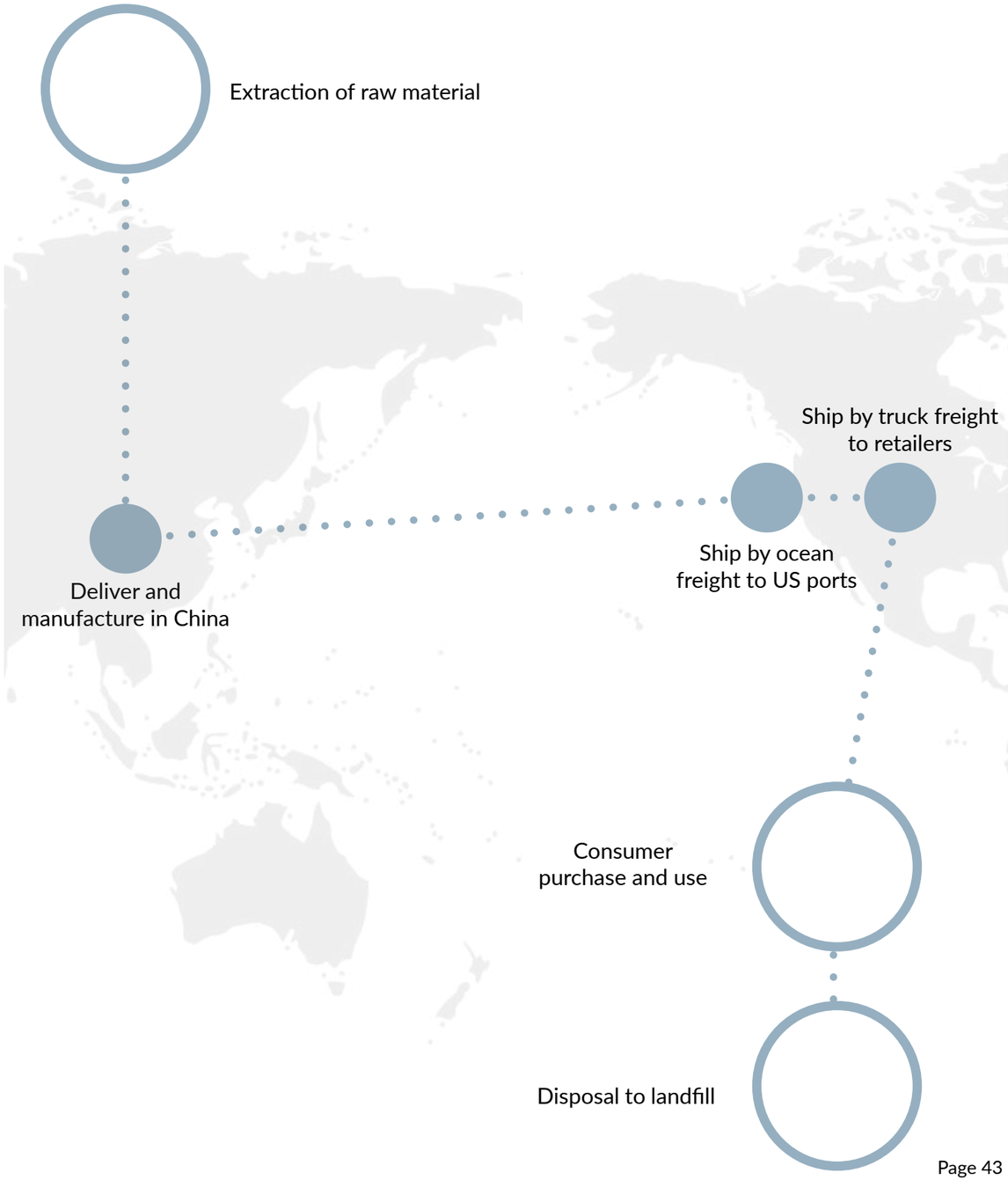
Because there is no existing data on the impact of dog toys on the environment, I decided to conduct a quick Life Cycle Assessment (LCA) using Okala Impact Factors. This was used to gain a brief understanding of where a dog toy's highest environmental impact lies throughout its entire lifecycle to move forward in the development process. Okala Impact Factors is a designer-friendly form of LCA developed with robust North American science. It was designed so that an understanding of ecological impacts can be factored into design decisions as early as the concept phase (Philip White, 2013). The tool includes a wide range of transportation, energy use, incineration, and landfill processes, which allow modeling of environmental performance over the entire life cycle. Computed in 2014, Okala Impact Factors contains impacts from the ten TRACI impact categories that are combined into a single score. However, because it is a single-score LCA, values for some materials and processes have been estimated. Most Okala Impact Factors have an average uncertainty of at least 10%, whereas extrapolated values (such as landfill) have an uncertainty of at least 20%.



EXTRACTION OF RAW MATERIALS LARGEST OVERALL IMPACT PER TOY

After gaining information about the manufacturing process and material components of dog plush toys, I was able to create an outline of a dog toy's overall lifecycle. From here, I decided to use a sustainability scoring guideline (Appendix D) to narrow down and choose three plush toys of varying levels of sustainability to determine and compare their overall environmental impacts. With a functional unit being per dog toy that lasts an "x" amount of time for an adult-sized dog, "Lasts" will be defined by the point at which the dog owner decides to throw it away. The three dog toys chosen were also at a comparable level of quality since all of their exterior materials were made with durable layers or backing to prevent the toy from being easily ripped apart to equal longer play. The main difference is that one toy uses recycled water bottles as stuffing and the other two toys use a conventional poly-fill. The calculations and results are located in Appendix D. Through this quick analysis, the highest impacts came from the extraction of raw material from each toy overall. Manufacturing (the orange bar) is not considered for the PetSmart toy because Okala Impact Factors is restricted in what operations to choose from and therefore was not an accurate representation of the manufacturing process.

LIFECYCLE OF A DOG TOY



DEFINE

AFFINITY MAPPING

After collecting all of my data, I used affinity mapping techniques with sticky notes to lay out everything in front of me. Out of all my initial research, expert interviews, online surveys, interviews with dog owners, and more, I picked out relevant data and key features to possibly answer my research question. From there, I decided to narrow down and group my data into categories or themes. I then narrowed them down again to be more specific.

From this, I came up with multiple themes to find trends, problem areas that current dog owners have with dog toys, and more. The three main themes found with the highest number of sticky notes were durability, communication, and aesthetics, which were also broken down into further subsections using yellow sticky notes. These included: lack of information or knowledge, cuteness, materials, health and safety, packaging and store experience, recycling, cost, and more.

In summary, dog owners currently desire dog toys that are cute (aesthetic), informational (easy to understand), and durable. From this, I decided to complete a “must-have, want-to-have, and nice-to-have” list to understand the hierarchy of needs. The “must-haves” comes from the overwhelming number of sticky notes from each category, marking them as the dominant need because of the consistency in responses from the research and interviews. The “want-to-haves” comes from ideas that I would like to have in the design but are unnecessary because they would not make or break a customer’s purchasing decisions. The “nice to haves” come from ideas/actions that dog owners desire, but it is okay if it is not attainable.

MUST HAVE

Cute and/or funny

Long lasting (2+ weeks)

Efficient communication

Safe for dog and planet

WANT TO HAVE

Squeaker

Sustainable materials

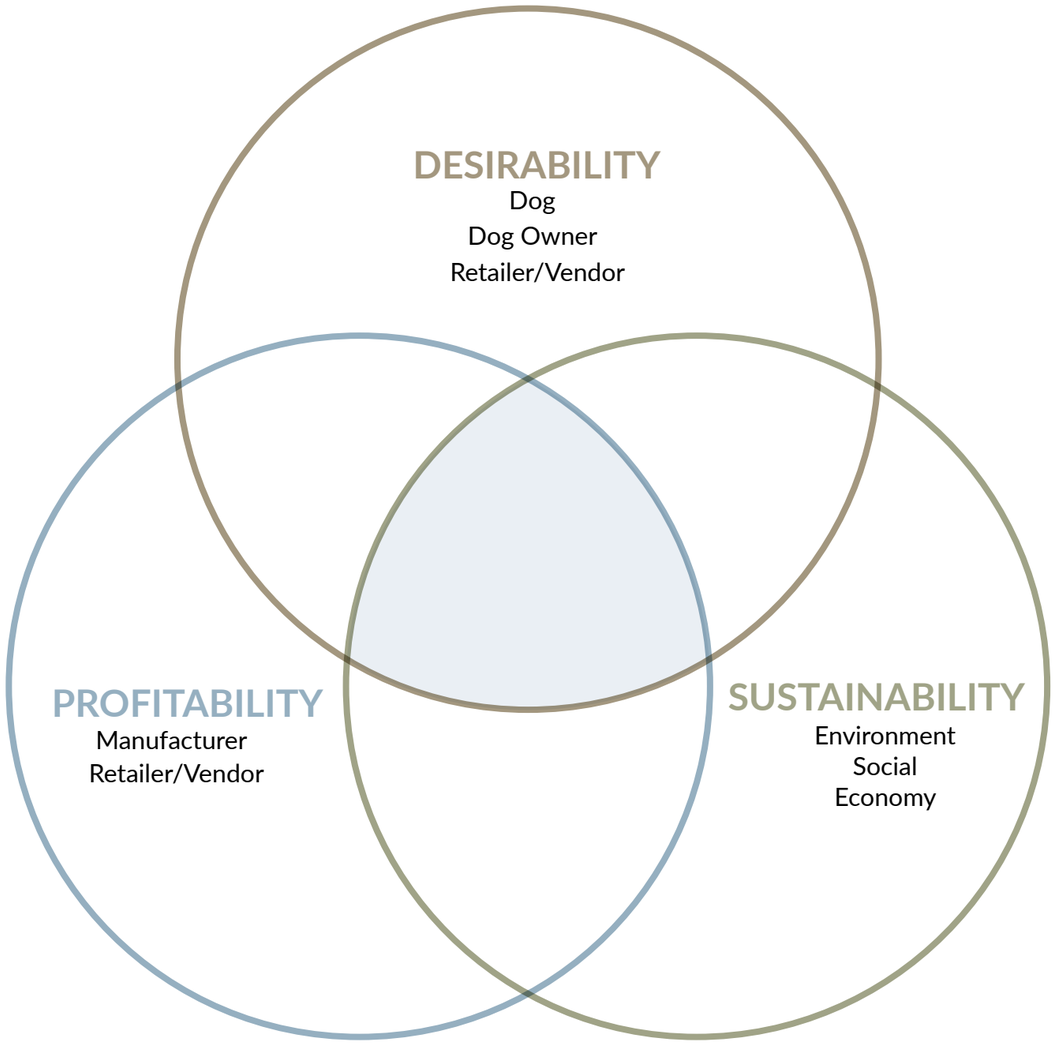
Cost neutrality

NICE TO HAVE

Ability to recycle

KEY STAKEHOLDERS

In all, for the design to be successful, it needs to come at the intersection between desirability, sustainability, and profitability. Desirability includes all three aspects of the user, the purchaser, and the seller. Profitability is desired by the people who produce, distribute and sell the product. And sustainability includes the three pillars of the people, planet, and profit. From here, is where I discovered six disconnects between the literature review and background research versus my conducted research with dog owners through online surveys, interviews, and more.



6 MAJOR DISCONNECTS

RECYCLABILITY

Recycling validates waste and should be the last resort when designing for sustainability due to several factors: high cost, the intense manufacturing process, potential toxins, and the result is typically at a lower quality. However, most dog owners defined sustainability as the ability to be recycled, and 3/8 dog owners verbally acknowledged their desire for a recyclable dog toy.

AESTHETICS

Eco-friendly and sustainable dog toys are currently in the muted and earth tone color palettes of browns, greens, and oranges. However, dog owners desire cute, funny, bright, and colorful dog toys that create an eye-catching aesthetic.

SUSTAINABILITY

Dog owners do not understand the language of sustainability. Most of them seemed apprehensive and had a lack of confidence in giving their definition of sustainability. But when they did, they typically defined it as something durable and recyclable. However, even though they do not understand it, they still desire sustainable products and practices.

MARKETING

Dog owners are interested in and purchase sustainable products, but dog toys are not on that list. There are many companies out there that sell sustainable dog toys, but a majority are only online. Since dog owners mainly shop in-store for their dog toys, this could be why they are “unseen” and unheard of in the market.

SQUEAKERS

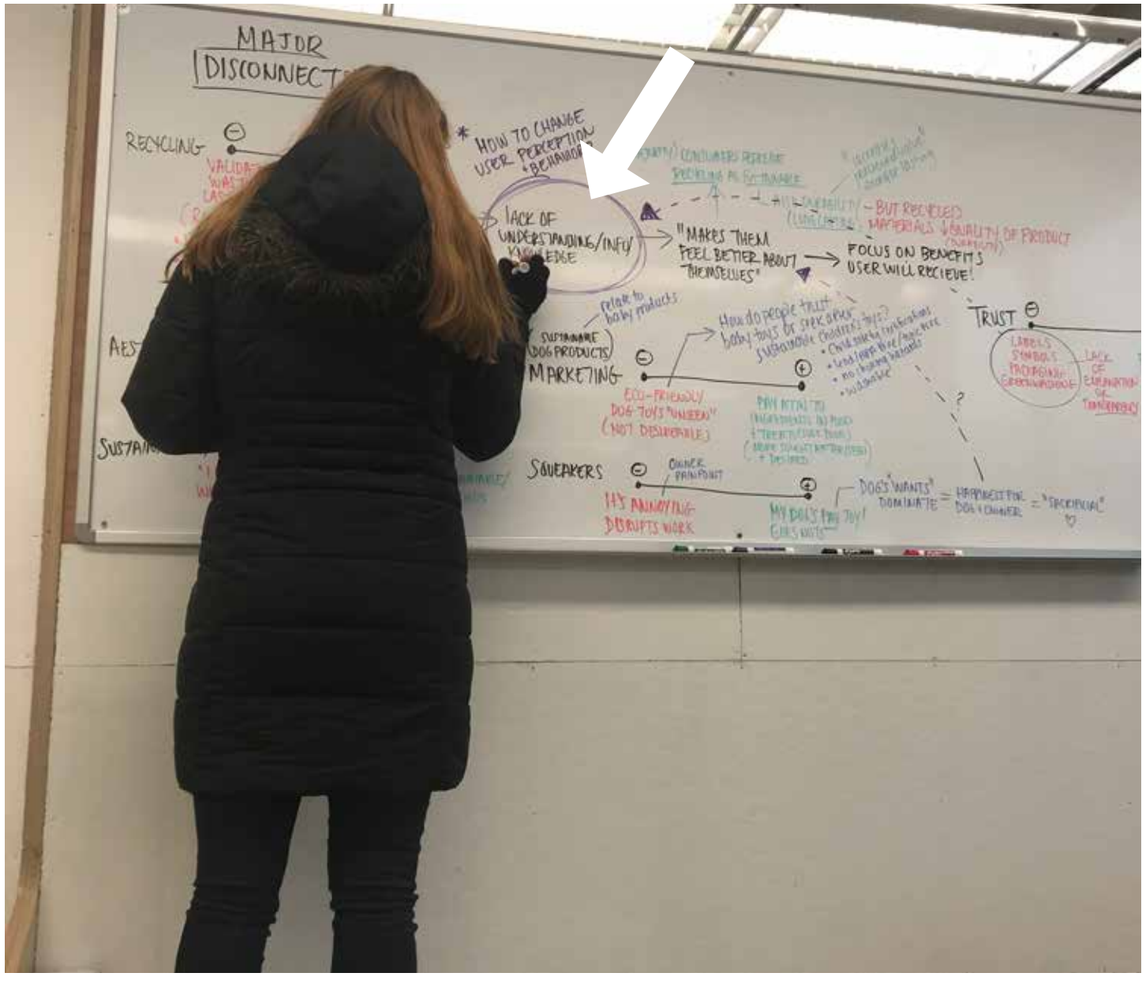
Squeakers can be annoying and disrupt their work, especially when working from home. Additionally, some dog owners are concerned about its choking hazards and their dog ingesting the plastic. However, squeaker dog toys are still highly desirable because they know their dog will like them, and it is their dog’s favorite type of toy.

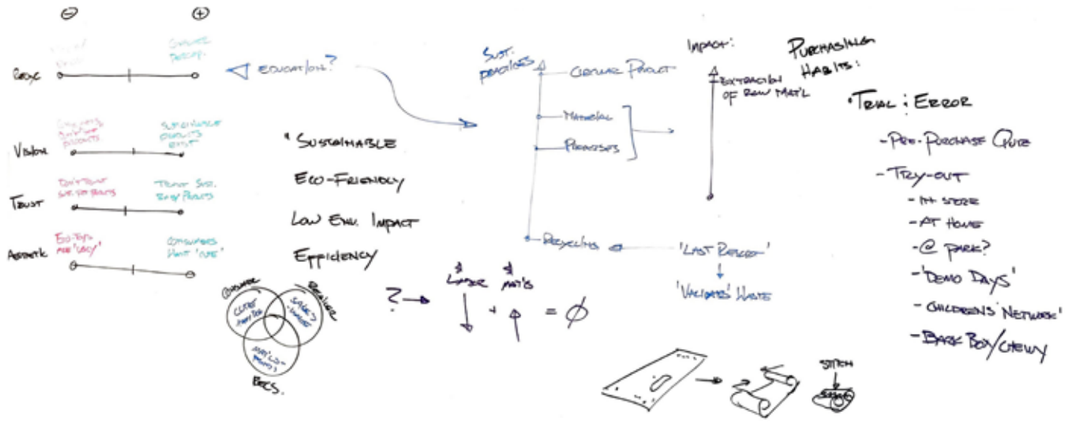
TRUST

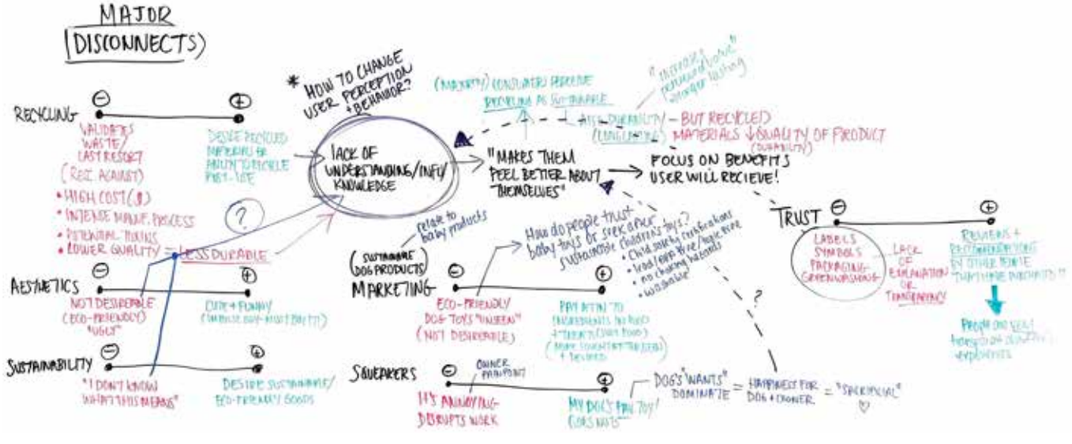
Labels on products are generally hard to find and understand. “Green-washing” and the lack of explanation lead owners to distrust the products they see. However, dog owners heavily rely on online reviews or recommendations because people are more transparent about their experiences with the product.

LACK OF UNDERSTANDING

By listing all of these disconnects, I realized they all drew to one conclusion: there is a lack of understanding across the board for dog toys or sustainable products in general. An improvement in communication techniques through product design and packaging could fix this. The problem is, however, that the majority of consumers perceive recycling as a sustainable option. Which then leads them to desire products made from recycled materials or with the ability to recycle. Even though recycling is a sustainable option, it is not the best solution. Utilizing recycled materials or recycling the end product is the last option designers should make because there are still environmental consequences associated with recycling. The current recycling system in the United States is not where it should be. Additionally, recycled materials decrease in durability and quality over time. The question then becomes: how can we still give dog owners what they want (durability and recyclability) but at a lower environmental impact?







SYSTEMS MAP

After collecting and analyzing the disconnects, I decided to do a systems map of how dog owners shop to understand their experiences throughout the journey. From my interviews, there were two different kinds of dog owners: new and experienced. New dog owners were those who have only owned a dog for a few months, whereas experienced dog owners were those who have owned a dog for a few years. New dog owners voiced concerns of “I finally figured out what my dog likes” after several months of trial and error. On the other hand, experienced dog owners were more likely to have confidence in their purchasing decisions. Two systems maps were created for both new and experienced dog owners and were used to identify dog owner personas.

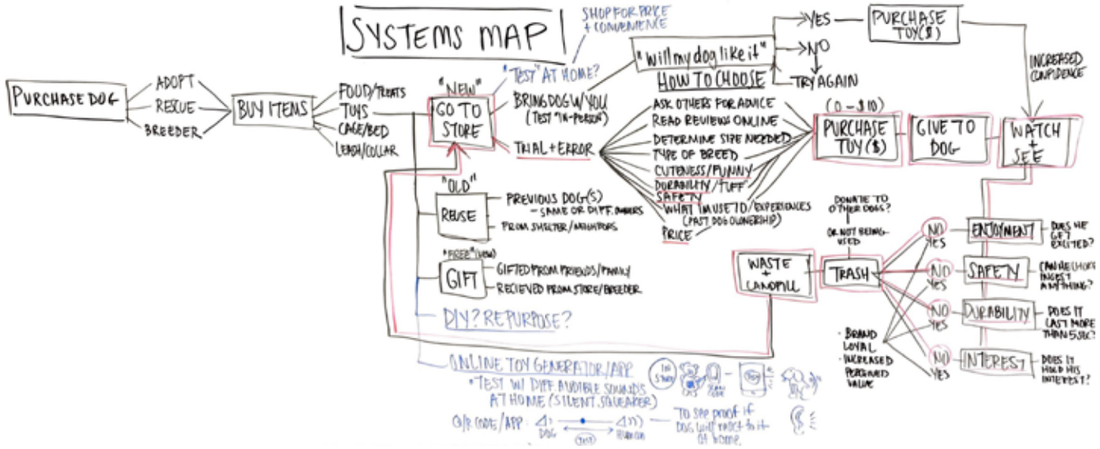
“TRIAL & ERROR”

From interviews with new dog owners, they purchased their dog through three main avenues of purchase: adoption, rescue, or from a breeder. I also realized they received their dog toys by buying new ones, reusing old ones from previous dogs previously owned, or receiving them as gifts from friends and family. Purchasing a new dog toy from a store was the most common method, so that was the main focus of the map. Going from there, they would typically buy the toy by trial and error or by bringing their dog with them. But since most of them did not shop at stores that allowed pets to come inside (like PetSmart or Petco), they would most likely bring it home first to see if their dog would like it. Before determining their purchase, several factors would come into play: cuteness/funniness, durability, safety, and price. However, new dog owners tend to focus on the type of dog (breed, size, etc.), ask others for advice, or research online. Overall, the reoccurring problem that new dog owners have is this constant cycle of “trial and error” of purchasing dog toys that either don’t last (will destroy in a few seconds) or their dog is not interested in it. Therefore, they either go to the trash or become a waste of money (not being used) and will keep going back to the store over and over again until they find the right fit. The right fit will include aspects of enjoyment, safety, durability, and interest. If it doesn’t fulfill all of these, it will most likely end up in the landfill.

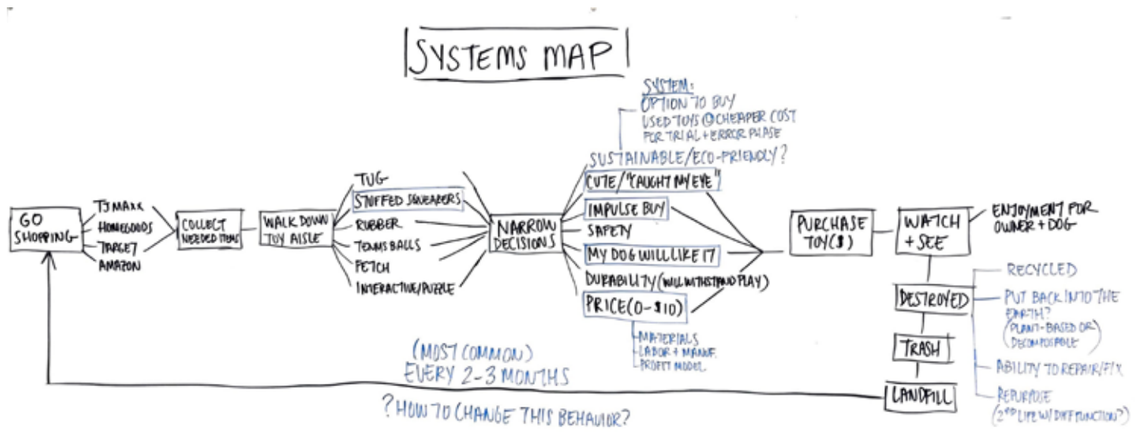
“IMPULSE BUYS”

Experienced dog owners typically shop at stores like TJ Maxx, Homegoods, or Target because they are shopping for themselves (groceries, clothes, etc.) and then decide to walk down the toy aisle to buy a new toy for their dog as a surprise when they get home. They typically will go for the stuffed squeaker plush toys because they know their dog will love it, even though it will not last longer than a few minutes or hours, and it is inexpensive ($1-$5). Their purchasing decisions combine cuteness, “caught-my-eye”, impulse buy, “my dog will like it”, and a price is under $10. Durability, safety, and sustainability are not areas of interest in this scenario because they know their dog enjoys tearing something up. If it is durable, it would not be as much fun for them. This cycle will then happen about every 2-3 months, totaling up to 4 or 6 toys per year. Even though it will only cost them about $20-$30 per year, it becomes a high cost to the environment because of their short lifecycle and addition to landfills. So how can we deter customers from making purchases like this and towards more sustainable purchasing decisions?

NEW DOG OWNER



EXPERIENCED DOG OWNER



DEVELOPING PERSONAS

From the previous ethnographic research, female millennial dog owners became the target user group. In a whiteboard map, all stakeholders combined with design strategies and criteria to see how they relate. I looked at what factors influence millennials, pet owners, and textile manufacturers the most, sustainability design strategies, dog toy themes/trends, and effective aesthetic and visual language techniques. Connections were found across the board and were then color-coded according to similar characteristics they share to create four personas of current dog owners.

MILLENNIALS

Based on my survey, the highest number of respondents were millennials (between the ages of 25-40 years old). Accordingly, based on feedback from the Director of Product Engineering at PetSmart, millennials will be the targeted audience in the next few years. Baby boomers are slowly losing their focus since the highest percentage of the current population are millennials. When looking into what types of things millennials desire, these can either be causes they support, beliefs, or products that interest them most. By combining this with my previous surveys and interviews with dog owners, I found nine factors for millennial dog owners that could impact the design direction of the dog toy: healthiness, convenience, experiences and adventures, relationships and community, customization and personalization, make a difference, communication and transparency, value, and climate change and environment.

SUSTAINABLE DESIGN STRATEGIES

According to the article by Oh, Oh concluded that the most fundamental missing piece of sustainable design was the social pillar (Oh, 2017). By utilizing the author's sustainable design guide, I was able to find 15 different strategies that related to the project to target all three pillars of sustainability.

TEXTILE MANUFACTURING

The processes of manufacturing plush dog toys are very similar. Once they gather the materials needed for production, it goes through a cutting process to cut out the shape and amount (either by metal stamp or CO2 laser cutter). It then goes to sewing to sew on any patterns, eyes, textures, etc. The final processes include manual labor to sew the ends together and add special features like squeakers and stuffing. Then it is off for shipment. Through this understanding, I realized some key opportunities that could either speed up the process or save money in the manufacturing process of plush dog toys. By increasing automation, the cost of manual labor would decrease. Therefore, allowing room for more sustainable (expensive) materials. The product can then remain cost-neutral. Additionally, minimizing the hand sewing process, number, and types of materials would save costs on time, labor, and materials.

DOG OWNERS

Several factors will draw a dog owner's eye when shopping. Because 95% of dog owners shop in-store, the in-store experience is invaluable to showcase the following to be a successfully marketed product on a retail shelf: cuteness, "will my dog like it", "newness", trust, and a tactile experience (soft, cuddly, etc.).

SUSTAINABILITY

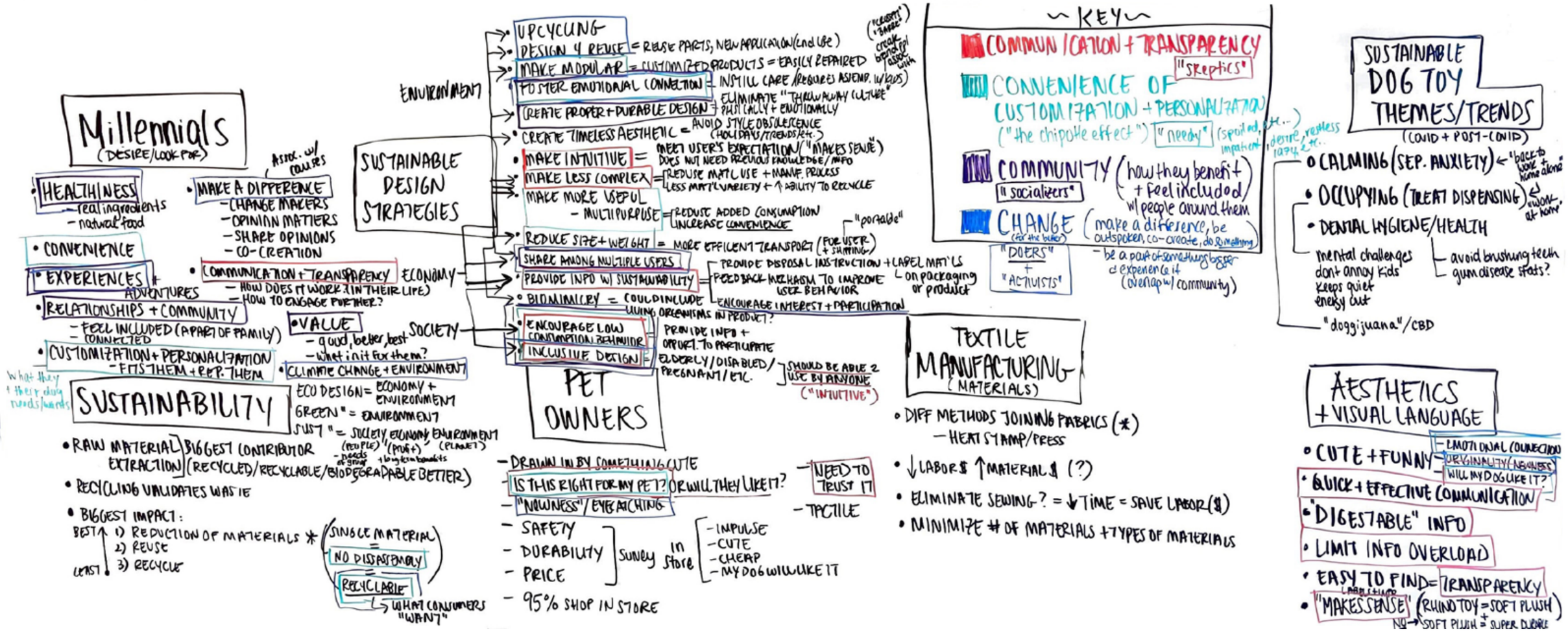
The most beneficial impact on the environment from best to least is reducing the number of materials, reusing the product, and then recycling the product (only after the first two are considered) (Oh, 2017). Also, the extraction of raw materials had the highest environmental impact from the initial LCA calculated by Okala Impact Factors. Reducing the number of materials in a product would require no disassembly and is consequently recyclable to avoid landfills. Along with this, using recycled, recyclable, or biodegradable materials would improve the LCA environmental impacts. These ideas align with dog owners' current definition of sustainability; however, the term sustainable often gets used interchangeably with eco and green design. Many people do not know that green design only targets the environmental aspects of sustainability. Eco-design only targets the economic and environmental aspects of sustainability. A truly sustainable product, however, meets all three pillars of society (people), environment (planet), and economy (profit).

DOG THEMES & TRENDS

From conversations with experts in the field, upcoming trends in the dog toy industry are: calming, occupying, and dental health and hygiene. Especially during the COVID-19 pandemic, as dog owners slowly return to work in person, their dog will need time to adjust for extended periods away from their owner.

AESTHETICS & VISUAL LANGUAGE

Dog owners desire cute and funny dog toys. It should provide an emotional connection, originality, and like-ability by the dog. Additionally, it should provide quick and effective communication to draw their attention visually and limit information overload.


Millennials
(DESIRE/LOOK FOR)
HEALTHINESS
- real ingredients
- natural food
CONVENIENCE
EXPERIENCES + ADVENTURES
RELATIONSHIPS + COMMUNITY
- FEEL INCLUDED (APART OF FAMILY)
- CONNECTED
CUSTOMIZATION + PERSONALIZATION
- FITS THEM + REP. THEM
MAKE A DIFFERENCE
- CHANGE MAKERS
- OPINION MATTERS
- SHARE OPINIONS
- CO-CREATION
Assoc. w/ causes
COMMUNICATION + TRANSPARENCY
- HOW DOES IT WORK? (IN THEIR LIFE)
- HOW TO ENGAGE FURTHER?
VALUE
- good, better, best
- what is it for them?
CLIMATE CHANGE + ENVIRONMENT
SUSTAINABILITY
ECO DESIGN = ECONOMY + ENVIRONMENT
GREEN" = ENVIRONMENT
JUST" = SOCIETY, ECONOMY, ENVIRONMENT
(PEOPLE) (PROFIT) (PLANET)
- needs of group
+ long term benefits
RAW MATERIAL EXTRACTION
BIGGEST CONTRIBUTOR (RECYCLED/RECYCLABLE/BIODEGRADABLE BETTER)
RECYCLING VALIDATES WASTE
BIGGEST IMPACT:
BEST
1) REDUCTION OF MATERIALS *
2) REUSE
3) RECYCLE
LEAST
* (SINGLE MATERIAL = NO DISASSEMBLY = RECYCLABLE) → WHAT CONSUMERS "WANT"
ENVIRONMENT
ECONOMY
SOCIETY
SUSTAINABLE DESIGN STRATEGIES
UPCYCLING
DESIGN 4 REUSE = REUSE PARTS, NEW APPLICATION/END USE
MAKE MODULAR = CUSTOMIZED PRODUCTS = EASILY REPAIRED
("CRAFTY" + "BADGE" creek bonding/ access with)
FOSTER EMOTIONAL CONNECTION = INSTILL CARE (REQUIRES ASSEMB. w/ KIDS)
CREATE PROPER + DURABLE DESIGN = ELIMINATE "THROW AWAY CULTURE" PHYSICALLY + EMOTIONALLY
CREATE TIMELESS AESTHETIC = AVOID STYLE OBSOLESCENCE (HOLIDAYS/TRENDS/etc.)
MAKE INTUITIVE = MEET USER'S EXPECTATION/("MAKES SENSE") DOES NOT NEED PREVIOUS KNOWLEDGE/INFO
MAKE LESS COMPLEX = REDUCE MAT'L USE + MANF. PROCESS; LESS MAT'L VARIETY ← ↑ ABILITY TO RECYCLE
MAKE MORE USEFUL - MULTIPURPOSE = REDUCE ADDED CONSUMPTION; INCREASE CONVENIENCE
REDUCE SIZE + WEIGHT = MORE EFFICIENT TRANSPORT (FOR USER + SHIPPING) "portable"
SHARE AMONG MULTIPLE USERS
PROVIDE INFO W/ SUSTAINABILITY = PROVIDE DISPOSAL INSTRUCTION + LABEL MAT'LS on packaging or product; FEEDBACK MECHANISM TO IMPROVE USER BEHAVIOR; ENCOURAGE INTEREST + PARTICIPATION
BIOMIMICRY = COULD INCLUDE LIVING ORGANISMS IN PRODUCT?
ENCOURAGE LOW CONSUMPTION REMINDER = PROVIDE INFO + OPPORT. TO PARTICIPATE
INCLUSIVE DESIGN = ELDERLY/DISABLED/PREGNANT/ETC.
SHOULD BE ABLE 2 USE BY ANYONE ("INTUITIVE")
PET OWNERS
- DRAWN IN BY SOMETHING CUTE
- IS THIS RIGHT FOR MY PET? OR WILL THEY LIKE IT?
- "NOVELTY"/EYE CATCHING
- SAFETY
- DURABILITY
- PRICE
SURVEY IN STORE
- IMPULSE
- CUTE
- CHEAP
- MY DOG WILL LIKE IT
- 95% SHOP IN STORE
- NEED TO TRUST IT
- TACTILE
KEY
COMMUNICATION + TRANSPARENCY ("SKEPTICS")
CONVENIENCE OF CUSTOMIZATION + PERSONALIZATION ("the chipotle effect") ("needy" (spoiled, impatient, etc... desire, reckless IDK, etc...)
COMMUNITY ("socializers") (how they benefit + feel included w/ people around them)
CHANGE (for the better) ("DOERS" + "ACTIVISTS") (make a difference, be outspoken, co-create, do something) - be a part of something bigger & experience it (overlap w/ community)
TEXTILE MANUFACTURING (MATERIALS)
- DIFF METHODS JOINING FABRICS (*) — HEAT STAMP/PRESS
- ↓LABOR$ ↑MATERIAL$ (?)
- ELIMINATE SEWING? = ↓TIME = SAVE LABOR($)
- MINIMIZE # OF MATERIALS + TYPES OF MATERIALS
SUSTAINABLE DOG TOY THEMES/TRENDS
(COVID + POST-COVID)
CALMING (SEP. ANXIETY) ← "back to work + home alone" ↔ "WFH at home"
OCCUPYING (TREAT DISPENSING)
DENTAL HYGIENE/HEALTH
mental challenges
don't annoy kids
keeps quiet
eneky out
- avoid brushing teeth
- gum disease stats?
"doggijuana"/CBD
AESTHETICS + VISUAL LANGUAGE
- EMOTIONAL (CONNECTION)
- ORIGINALITY (NOVELTY)
- WILL MY DOG LIKE IT?
CUTE + FUNNY
QUICK + EFFECTIVE COMMUNICATION
"DIGESTABLE" INFO
LIMIT INFO OVERLOAD
EASY TO FIND = TRANSPARENCY
"MAKES SENSE" (RHINO TOY = SOFT PLUSH) NO → SOFT PLUSH + SUPER DURABLE

CONNECTIONS

Once I developed key aspects under the seven major stakeholders and design strategies, I decided to focus on the similarities between millennials, dog owners, and sustainability strategies to create personas. The nine factors for millennial dog owners that corresponded with the fifteen sustainable design strategies guide found from a sustainable strategies design guide (Oh, 2017) were used to develop personas (see right). In summary, connections found were between relationships, communication, environment and change, and convenience. Personas are created on page 58.

THE "DOERS"

These are the change-makers. They want to make a difference, be outspoken, co-create, and do something actionable. They want to be a part of something bigger and experience it. They are vocal and opinionated and not afraid to stand up for what they believe.

THE "SOCIALIZERS"

These people desire community, relationships, and a family-like atmosphere. They want to feel included or a part of something bigger, with people around them that support their beliefs and who they are. Additionally, they want to understand how they benefit from a situation or experience before they partake in something.

THE "NEEDY"

These are the impatient, restless, and sometimes lazy where they don't want to spend extra time on something and extended effort if they don't have the time to put forth towards it. They want it to be easy and convenient, also known as "The Chipotle Effect." This is where the experience or product can be easily customized towards their needs and wants.

THE "SKEPTICS"

These lack trust and require transparency in anything they purchase or do. They desire more information on labels and products because they want to know every detail of what is going in their dog's mouths or how to dispose of it if it is recyclable. They also desire digestible information and clear instructions because they are visual people with short attention spans. Overall, communication is important to them.

MILLENNIAL DOG OWNERS

1. **HEALTHINESS** — Natural ingredients and remedies
2. **CONVENIENCE** — Saves time, money, and effort
3. **EXPERIENCES** — Adventures, trying new things, create memories
4. **RELATIONSHIPS** — Desire community, inclusion, connection
5. **PERSONALIZATION** — "Chipotle effect" and customization
6. **CHANGE** — Desire to make a difference, be heard
7. **COMMUNICATION** — Transparency and easy to understand
8. **VALUE** — Best value for money and themselves
9. **ENVIRONMENT** — Advocates to better the earth, takes action

SUSTAINABLE DESIGN STRATEGIES

ENVIRONMENT	SOCIETY	ECONOMY
Upcycling	Inclusive	Emotional connection
Design for reuse	Stimulate community	Reduce size
Durability	Encourage low consumption	Service/system
Modularity	Informative	Timeless aesthetic
Multipurpose	Intuitive	Less complex

“DOERS”

Desire to create change
Want to be a part of something
Vocal and opinionated

“SOCIALIZERS”

Want to be in a community
Desire relationships
Value towards self

“NEEDY”

Desire convenience
Self-centered
Require little energy or thought

“SKEPTICS”

Desire transparency
Lack of trust
Communication is important

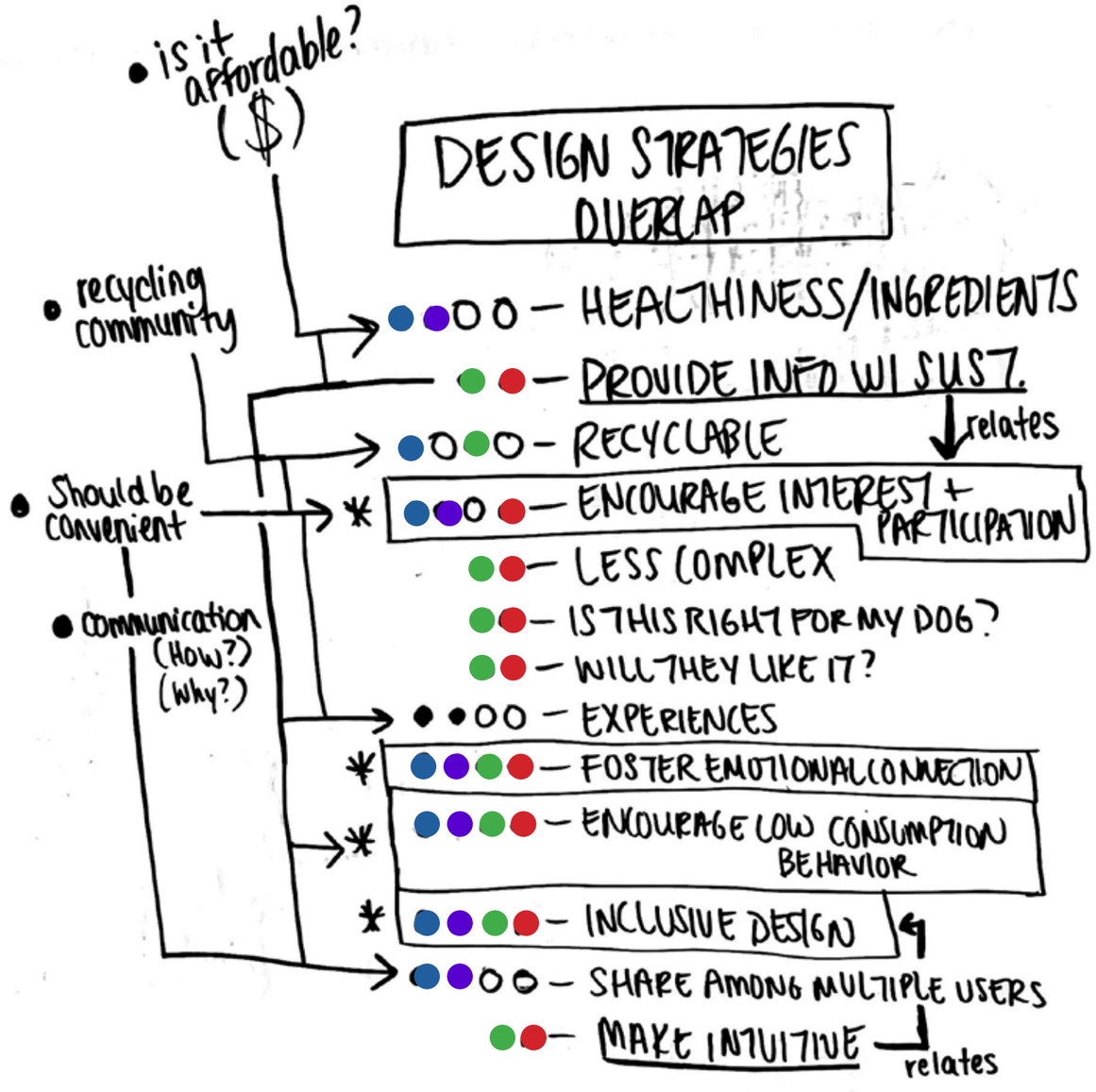
DEVELOPING DESIGN CRITERIA

After creating the four personas, I started to develop design criteria by finding the overlaps between the seven aspects of my data highlights overlapped with each persona (that was color-coded for easy understanding). Any heading circled twice or more (on pages 54 & 55 - with different colors) was put under the category “design strategies overlap.” Thirteen overlaps were found with two or more personas attached to each to create design criteria. This was done so that it would fit the largest range and number of personas created previously.

Three design strategies had all four personas included. These were: foster emotional connection to the product, encourage low consumption behavior, and inclusive design. Only one strategy had three personas attached: encourage interest and participation. Therefore, these were the key highlights found and investigated moving forward. However, after further analysis, it was realized that some strategies missing a persona provided areas of opportunity. For example, under the strategy “encourage interest and participation,” the persona missing was “the needy.” Therefore, the participation aspect should be convenient for them to be a successful design strategy. As well as the strategies “healthiness”, “recyclable”, “experiences,” and “share among multiple users,” the persona “the skeptics” were missing because effective communication is needed for it to be a successful design strategy, where consumers are willing to purchase it. Overall, the gaps in the process turned out to be essential design criteria to cater to all the personas needs, wants, and desires.

From the results, the design would first focus on a physical dog toy design. Following would be the package design and the in-store experience to complete the entire business model.

Afterward, I created a whiteboard map (on the next page) to figure out how to meet both the engineering and manufacturing side of sustainability while still including the desires of the consumer and retailer to attract purchase and investment into the product.



WHITEBOARD MAPPING

The whiteboard map divides into two categories: retail strategies and sustainability strategies. The retailer's main objective is to make a profit. To have a successful line of sustainable products, they would need to be consistently desired by the consumer to remain a steady stream of income. Consumers want something that their dog will always enjoy but should still be within a few dollars as its competitors.

For a product to be sustainable in manufacturing and engineering, it should reduce the number and types of materials it uses, be made out of recycled, recyclable, and biodegradable materials, and be designed to last longer physically and emotionally. For a product to be sustainable in the retail aspects, it should provide information about sustainability, foster an emotional connection to the product, encourage low consumption behavior, encourage interest and participation, be made intuitive, and inclusive. Overall, the product will not be successful if a dog owner cannot see that their dog will like it. If this is unmet, each of the other strategies will not matter when it comes to a dog owner's purchasing decisions.

Overall, the key finding for one of my design criteria is to use a single material. From my research, the best way to reduce the impact on the environment from best to least is by reducing the number and types of materials, reuse, and recycle (after the first two were acknowledged). By using a single material, it would require no disassembly. Therefore, it would also become recyclable (if the material is recyclable itself). Recyclable products are desired by dog owners in addition to sustainable practices and purchasing decisions. No disassembly is advantageous to the manufacturing process because a single material would decrease the time used in production, assembly, and receiving or produce materials. Therefore, this could lower the manual labor costs from sewing and leave an opportunity to increase the material costs to have more sustainable materials since they are more expensive to acquire and remain net zero. A single material design is also less complex and minimizes material variety. With fewer steps in the entire production process, it can save time and money to leave room for more environmentally friendly and sustainable options.

SINGLE MATERIAL

Less complex
Minimizes material variety
Reduced material acquisition

=

NO DISASSEMBLY

Great for manufacturing
Decrease production and assembly time
Decrease cost of labor
Opportunity to choose sustainable materials that are typically more expensive

=

RECYCLABLE

Defined as sustainable from dog owners
Desired by dog owners
Good for environment

REFINING DESIGN CRITERIA

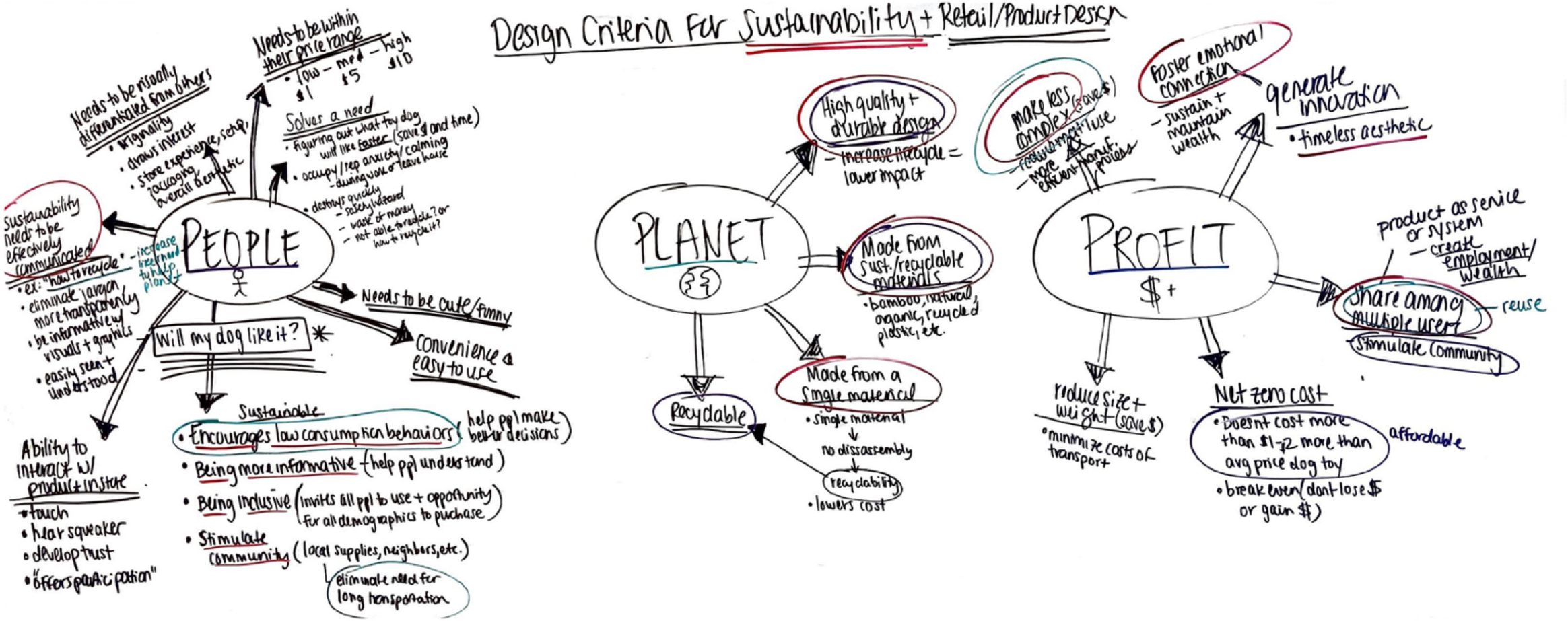
To start refining and developing the design criteria, I decided to divide it into the three core values of sustainability. To make sure I am creating a sustainable product, it needs to meet every core value. The three core values, in simplest terms, are the people, planet, and profit. Additionally, to create a product that consumers are willing to buy, the retail and product design must be incorporated. Even if I designed the most sustainable dog toy, if it is not desirable by the retailers that sell it or the dog owners viewing it, it will be unsuccessful.

The three pillars of sustainability are defined below:

People: Represents social equity. The social aspect of sustainability focuses on balancing the needs of the individual with the needs of the group. This can be on the business/employee side with equal benefits, benefiting the community, skills training, disaster relief, etc. Anything to make a person better, happier, and able to continue and grow in the future.

Planet: Represents the environment and often gets the most attention. This focuses on reducing carbon footprints, packaging waste, water usage, and overall effect on the environment.

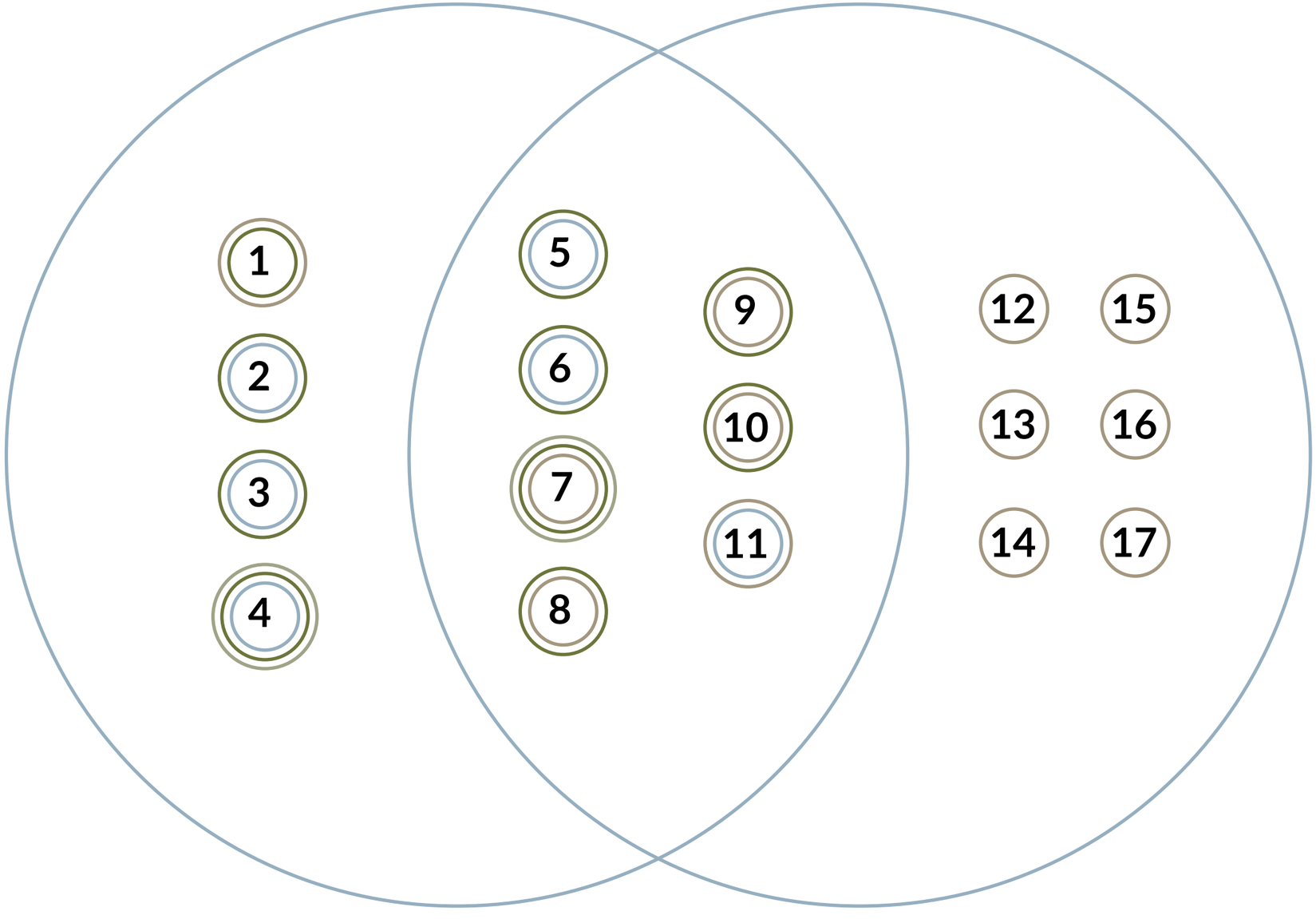
Profit: Represents the economic pillar. To be sustainable, a business must be profitable. The idea is to promote the use of those resources efficiently and responsibly that provides long-term benefits and establishes profitability. A profitable business is more likely to remain stable and continue to operate from one year to the next. The nice thing about taking a total approach to sustainability is that if you focus on social and environmental issues of profitability will often follow. Social initiatives have an impact on consumer behavior and employee performance, while environmental initiatives such as energy efficiency and pollution mitigation can have a direct impact on reducing waste.



REFINING DESIGN CRITERIA

The three pillars were separated, but I realized an overlap between what dog owners wanted, what society wants, what the planet wants, and what businesses and the economy want. Therefore, these four areas were placed into a regular Venn diagram to see the overlaps of where sustainability, retail and product design, and dog owners align.

- DOG OWNERS
- PLANET
- BUSINESS & ECONOMY
- SOCIETY & COMMUNITY



SUSTAINABILITY

What the people, planet, and economy wants

KEY

1. Encourage low consumption behavior
2. Foster emotional connection to product
3. Create timeless aesthetic
4. Product as a service or system
5. Made from single material
6. Make less complex
7. Sustainability effectively communicated
8. Recyclability
9. High quality and durable design
10. Made from sustainable materials
11. Net zero cost
12. Will their dog like it?
13. Visually differentiated from others
14. Cute & funny (aesthetics)
15. Within price range ($1-$5) of competitors
16. Solves a need/want
17. Ability to interact with product in store

RETAIL/PRODUCT DESIGN

What the dog owners (people), retailer, and manufacturing wants

REFINING DESIGN CRITERIA

I then made it into a triple Venn diagram (right) to see what aspects came to be the most important. In a ranking of hierarchy, what dog owners want trump anything else by 65%, then planet-focused items (59%), then business and economy-focused (35%), then society and community (18%). However, everything that society wants is all within the green circle (planet), and each one touches on a different pillar of sustainability. Society is separate because “people” are the dog owners, and “society” is the general public. From here, I was able to narrow down my design criteria by using multiple strategies that meet all three pillars of sustainability and the desires of the retail industry and dog owners, with a heavier focus on the needs of the dog owners.

65%

Focused on dog owners’ needs, wants, and desires

59%

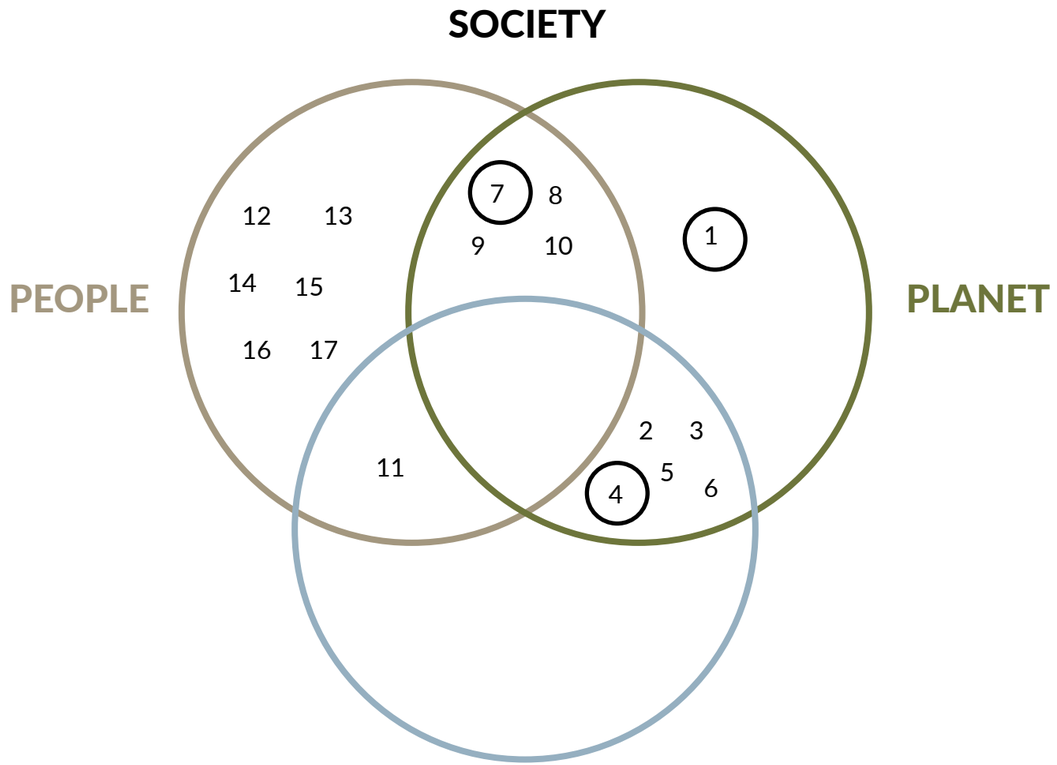
Focused on needs of planet

35%

Focused on business and economy

18%

Focused on needs of people and society



MUST HAVE

Recyclable
Made from single material
Durable
Cute and/or funny
Within price range
Effective and efficient communication
Solves consumer need or problem
Targets all 3 pillars of sustainability

WANT TO HAVE

Made from sustainable materials
Less complex and simple design
Encourage low consumption behaviors

NICE TO HAVE

Timeless aesthetic
Foster emotional connection to product

DEVELOP

MIND MAPPING

Brainstorming began by developing three mind maps based upon systemization, recyclability, and durability. I chose these three categories because they are a combination of the main aspects from the Venn diagram on page 71. The breakdown is as follows:

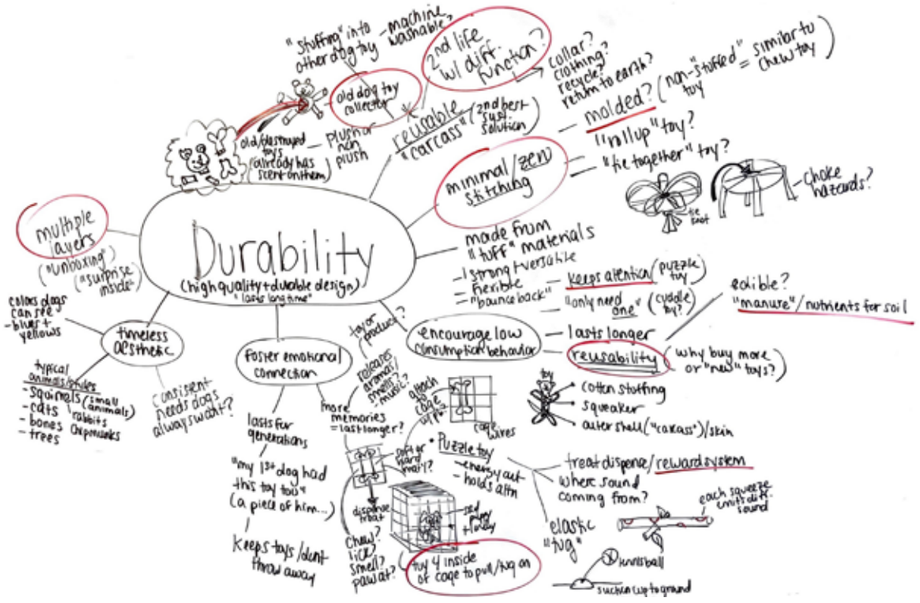
Systemization:
Product as a service or system, solves consumer need, sustainability effectively communicated, foster an emotional connection to the product, within the price range ($1-$5), or a net-zero cost for retailers and manufacturers, and encourage low consumption behaviors.

Durability:
High quality and durable design, encourage low consumption behavior, sustainability effectively communicated, create timeless aesthetic, foster emotional connection to the product, within the price range ($1-$5) or a net-zero cost for retailers/manufacturers.

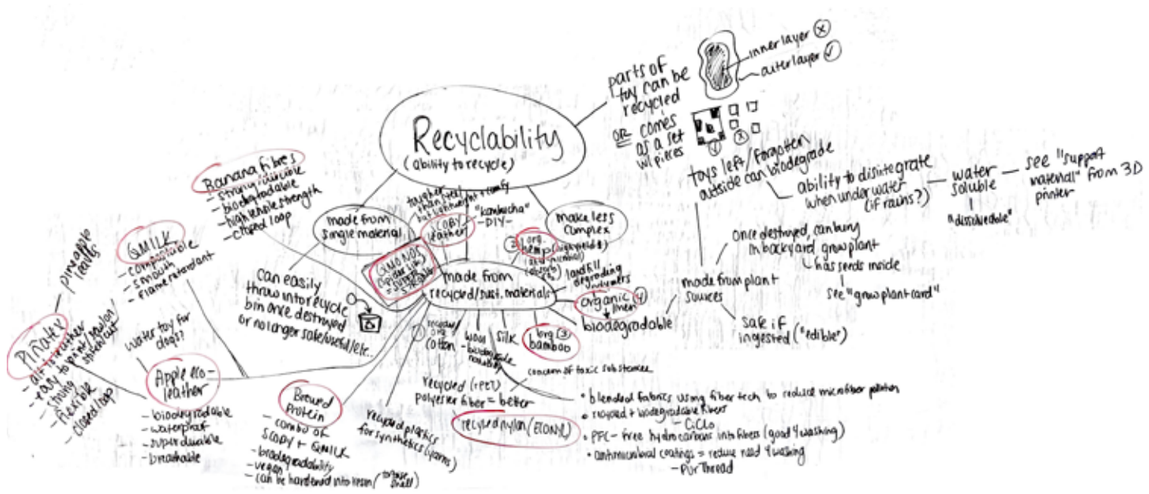
Recyclability:
Ability to recycle, made from a single material, made from recycled or sustainable materials, net-zero cost, within the price range ($1 - $5), make less complex, and sustainability effectively communicated.

SYSTEMIZATION

DURABILITY



RECYCLABILITY



INSPIRATION FROM PREVIOUS PROJECT

The idea for this project stemmed from a Make10 class project taught by Stephen Chininis in the School of Industrial Design, where I developed a dog tug toy made out of upcycled braided t-shirts and a 3D-printed handle. Accompanying the toy came with how-to instructions to reuse the handle by remaking the braid themselves once it got destroyed. Even though I sold all 10 of my created dog toys and a few extras, I realized the sustainable business model had several design flaws:

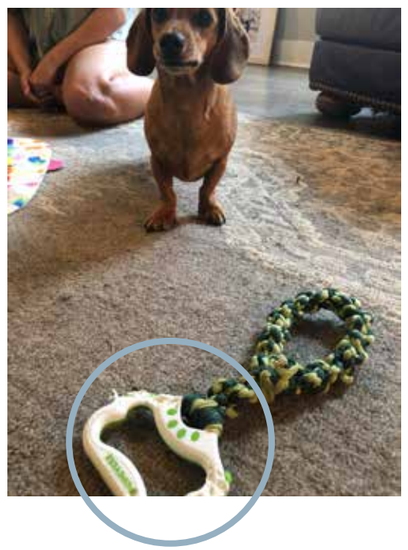
1. People did not take the time to remake the braid with their t-shirts even though I provided paper and video DIY instructions. Instead, they just threw it away when it became unraveled or chewed up. Therefore, my attempt at trying to get dog owners to reuse the handle was unsuccessful.

2. I thought I made it clear to avoid letting the dog chew on the 3D printed handle since it could be harmful to the dog if pieces were bitten off and swallowed. However, almost every dog owner didn't prevent it from happening due to the time it would take to supervise the dog during play and because most dog owners keep a toy box out that is available to them 24/7.

3. I realized a 3D printed handle is not the most sustainable solution or material because it produces new raw material into the environment and is potentially hazardous to dogs.

From these findings, I realized I could use upcycled t-shirts as stuffing instead of making them into a braided rope to adhere to my single material design criteria. Ideas were generated upon this as well as several others.

DOGS CHEWING ON THE HANDLE

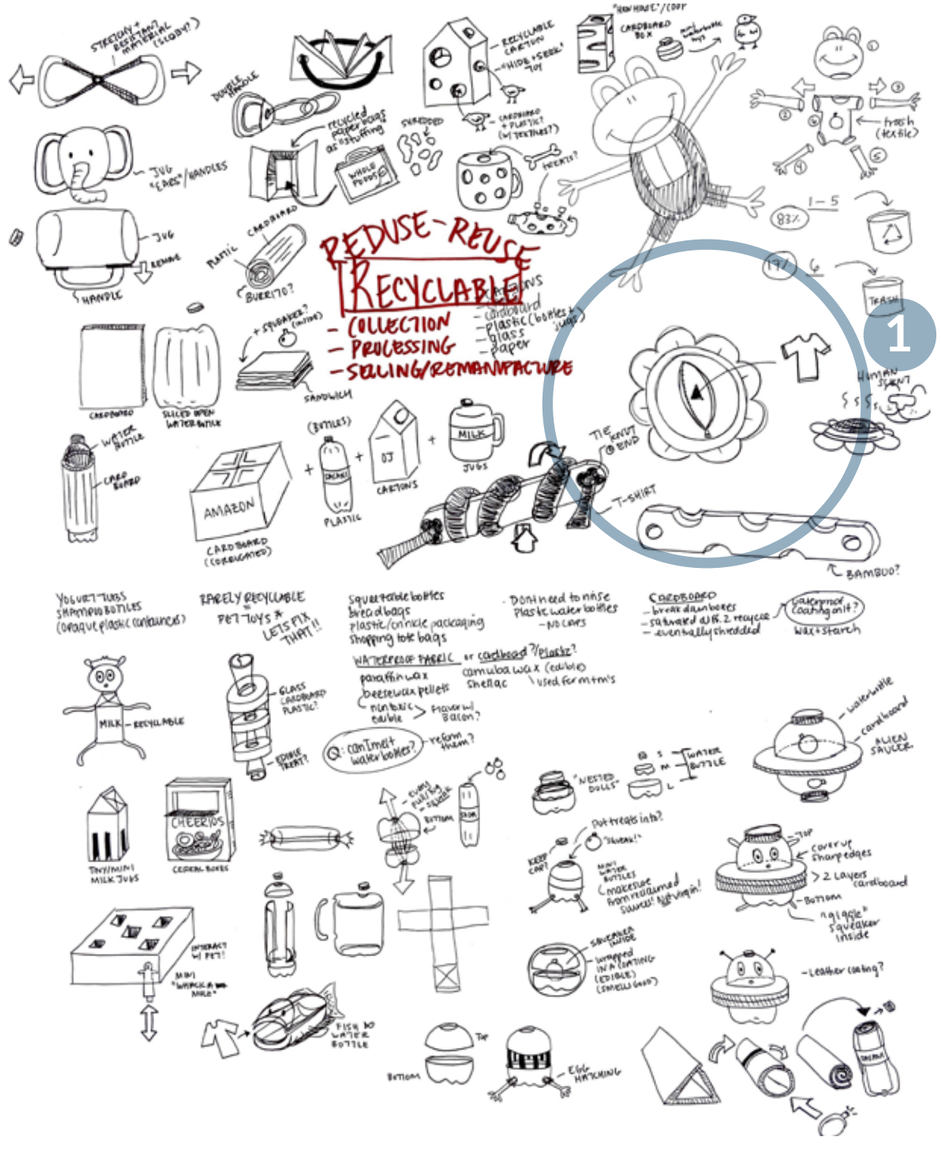


AFTERMATH

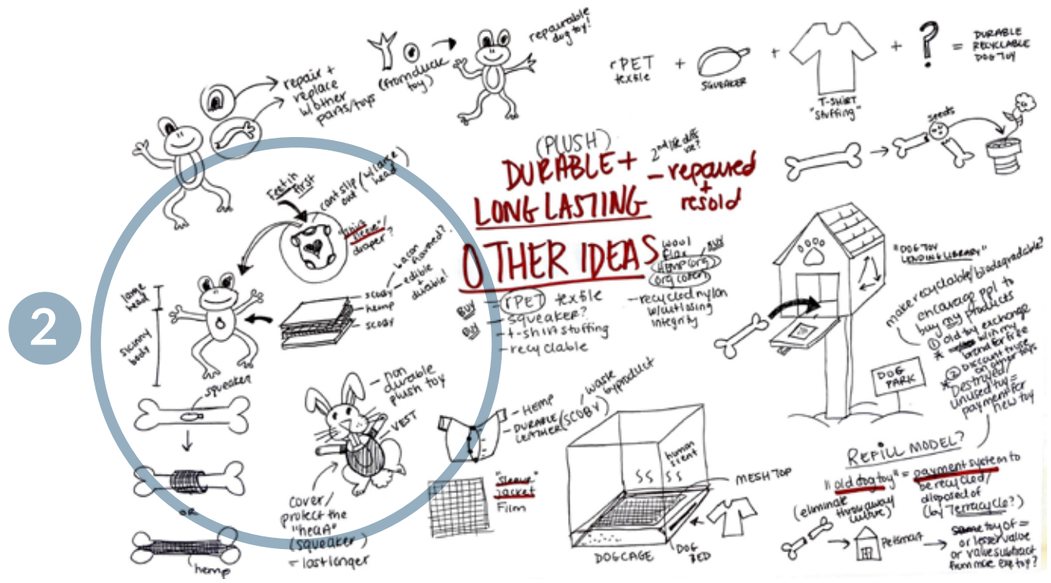
IDEATION

From there, I then started to develop sketches from each category and ideas narrowed down to four: A t-shirt stuffed dog toy, a “bulletproof vest” over the toy to protect the squeakers, a reversible toy with an exterior rubber shell and interior plush-like material, and a “smart” squeaker toy that can suction cup to the floor and the sounds of the squeaker can be adjusted.

RECYCLABILITY



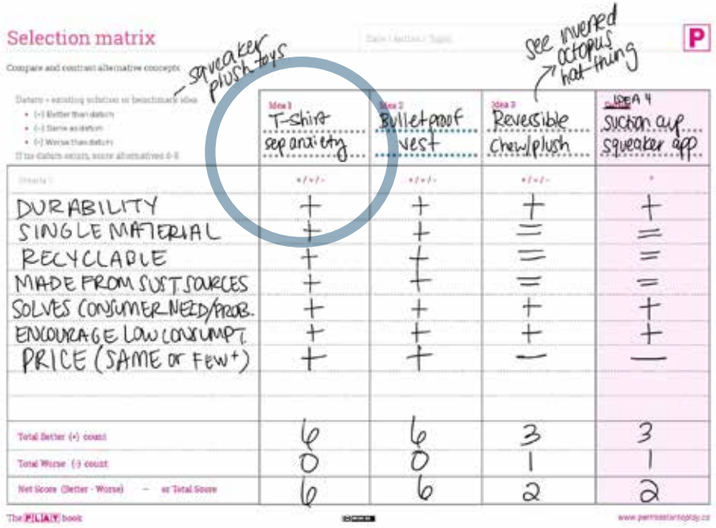
DURABILITY

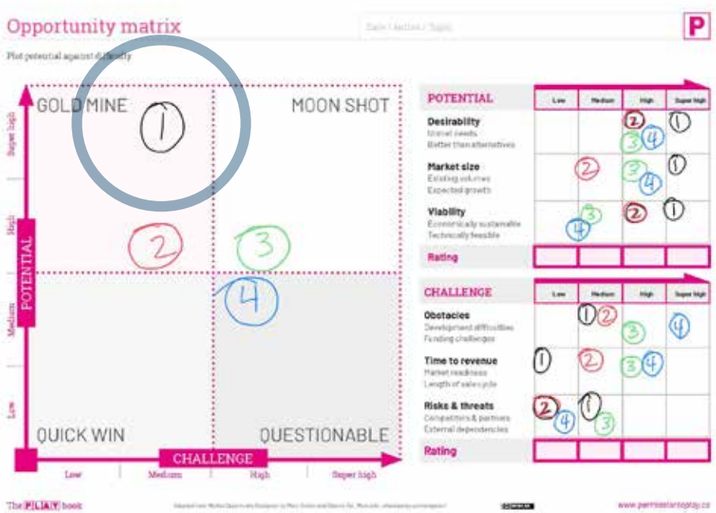


SYSTEMIZATION

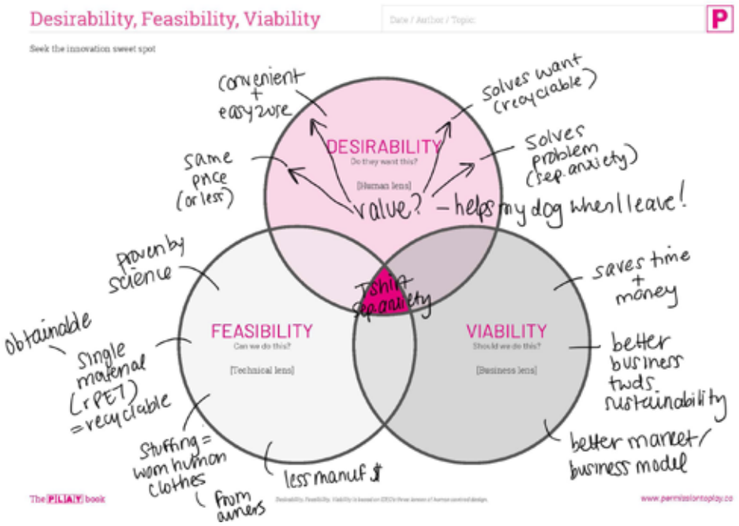
NARROWING IDEAS

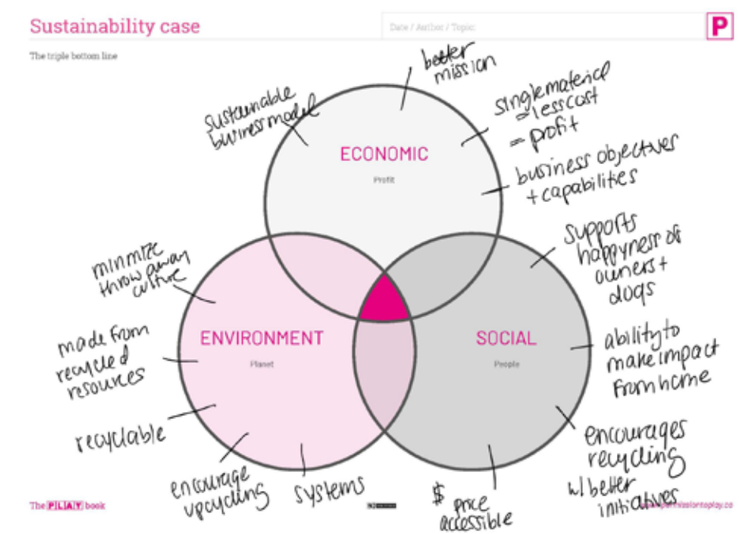
To narrow down my ideas, I found a free toolkit called “Playbook” from the website “Permission to Play” that offered guided exercises and techniques to help develop creative ideas. I used a selection and opportunity matrix to determine desirability, feasibility, and viability. Through this exercise, idea one and idea two tied in the selection matrix, but idea one had the highest opportunity in the opportunity matrix. Overall, the highest potential for success was with the t-shirt stuffed dog toy idea.





After narrowing down to the t-shirt stuffed dog toy idea, I determined that the desirability, viability, feasibility, and sustainability aspects were all met through the Venn diagram exercise. Because the t-shirt stuffed dog toy idea was simple, but it had multiple layers to it. For example, it could be made out of a single material because there is no stuffing, and therefore, it is recyclable. Therefore, this gave me confidence in moving forward with the concept.



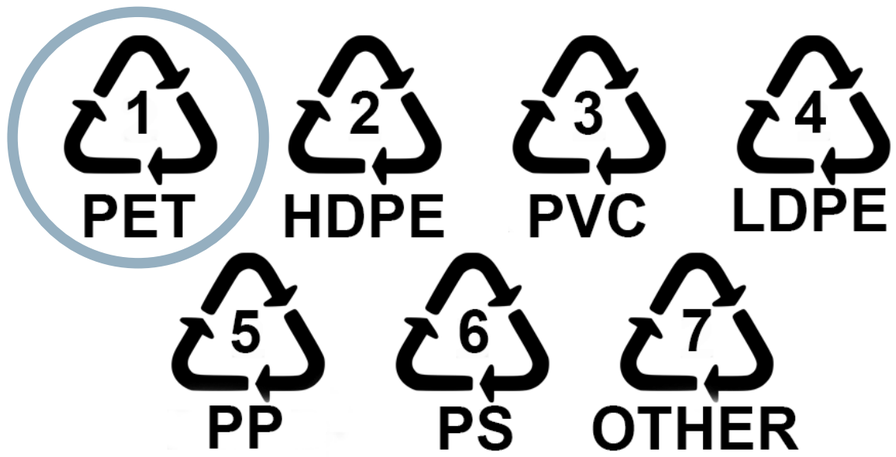


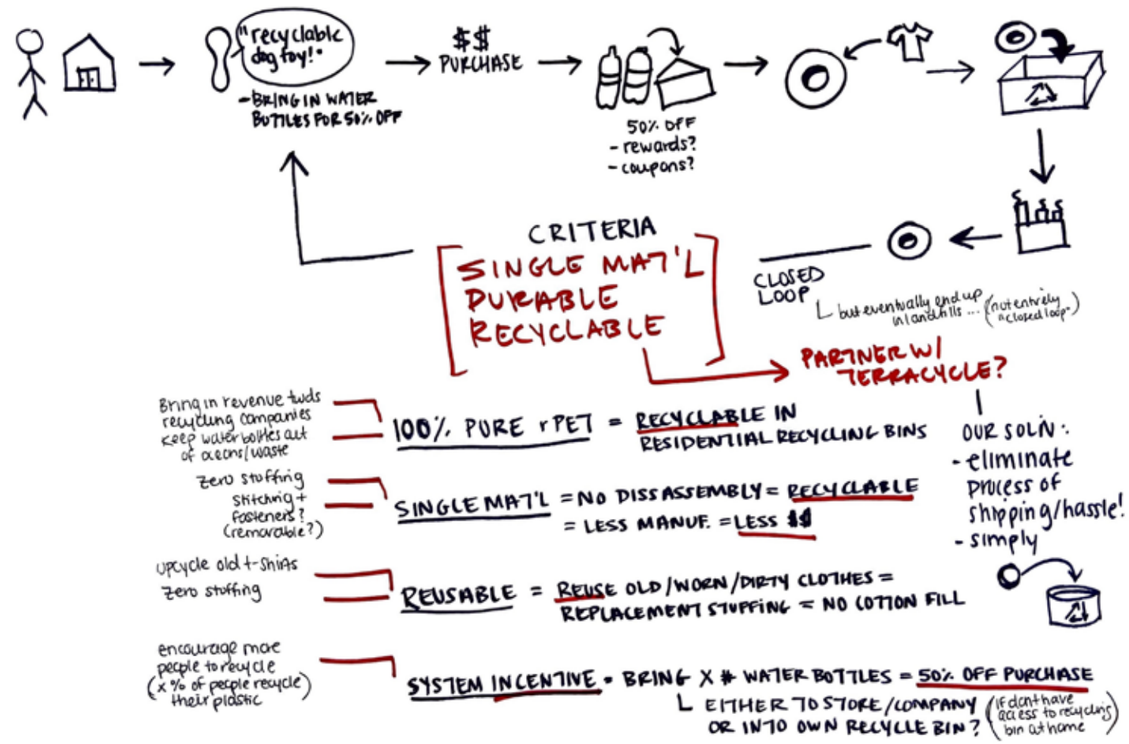
T-SHIRT STUFFED DOG TOY CONCEPT

From here, I started thinking about how this concept would work systematically. I thought about the materials, the business model, and the stakeholders involved.

For example, as the dog owner goes to the pet store, they will see a dog toy on the shelf that reads “recyclable dog toy.” But, if they bring in their water bottles to recycle, they will get 50% off (or something like that). Since the material gets created from rPET (recycled plastic water bottles), encouraging dog owners to bring in water bottles to be recycled would also provide more materials to recycle the water bottles into new dog toys. However, some flaws exist due to the questions: what if dog owners do not currently use plastic water bottles, or what if they start buying plastic water bottles to only get the discounted rate on their toys?

After they purchase the toy, they would then stuff it themselves with their t-shirts and give it to their dog to play. Once it reaches its end of life (deemed by the dog owner), they would remove the clothing from the toy and conveniently place the toy into their residential recycling bins. Since the toy would be spun from 100% rPET and woven into a textile, I assumed that recycling bins would accept it since it is the same material as water bottles (see below). From there, it would go to the recycling facility and close the loop to continue making more dog toys from the original material.

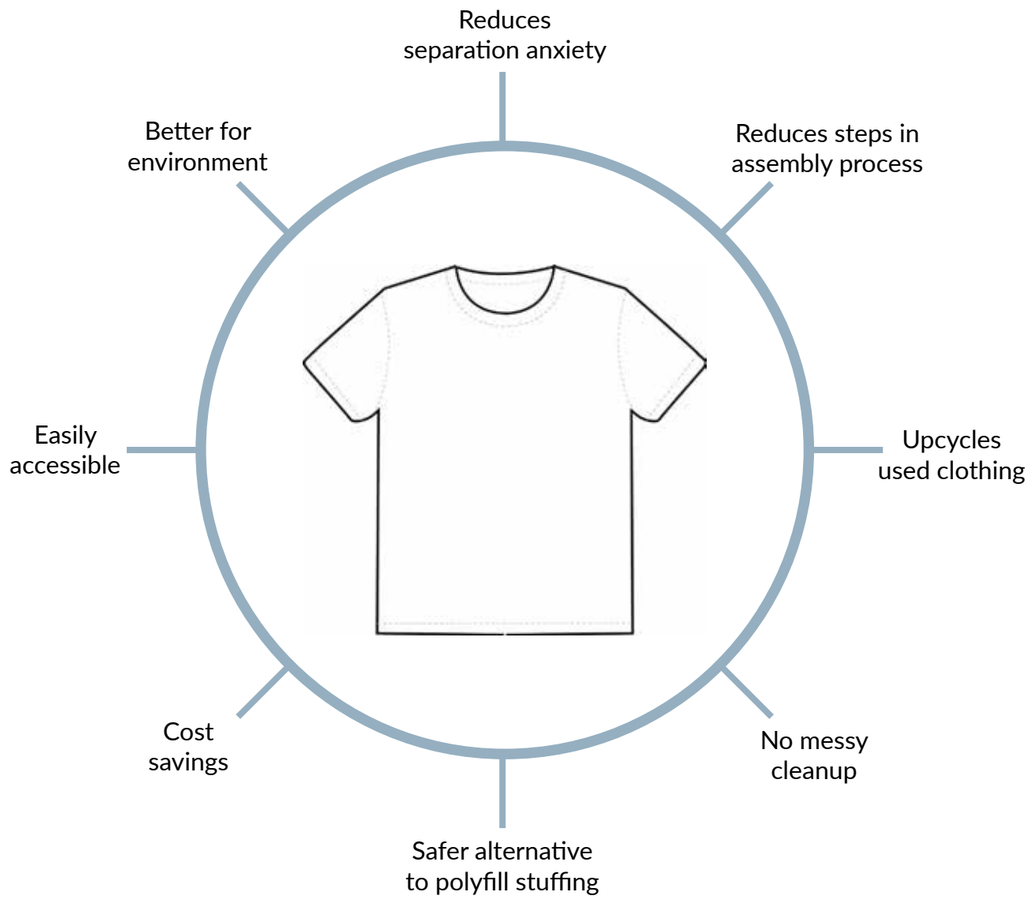




WHY T-SHIRTS?

According to a saliva test done by Yoon-Joo Shin, and Nam-Shik Shin, leaving a dog alone in a room with their owner's clothes decreased their cortisol (stress hormone) levels versus not having their clothes with them. Another study conducted by neuroscientist Gregory Berns and his team at Emory University's Center for Neuropolicy used advanced brain imaging to discover that dogs had the most positive emotional response to their owner's armpit scent versus other scents (Berns, 2015). Therefore, the results indicate that increasing stress hormone levels due to the owner's departure could psychologically be reduced by allowing dogs to sniff the owner's odor through t-shirts.

In addition to this, replacing plush toys internal stuffing (polyfill) with used t-shirts, eliminates steps in the assembly process, lowers cost, no messy clean-up for dog owners, and reduces ingestion or choking hazards from the polyfill. T-shirts are readily accessible by the everyday dog owner, and upcycling them into the toy provides a sustainable alternative and happier dogs.



EXISTING PRODUCTS

Before expanding on the idea, I looked at the existing market where there might be an opportunity or even potentially similar ideas to avoid duplication. The plush dog toys below relieve separation anxiety through four different methods: heartbeat simulation, microwavable heating devices, calming drops, and used fabrics (sheets, socks, etc.). Overall, they each appeal to two senses: touch and smell.

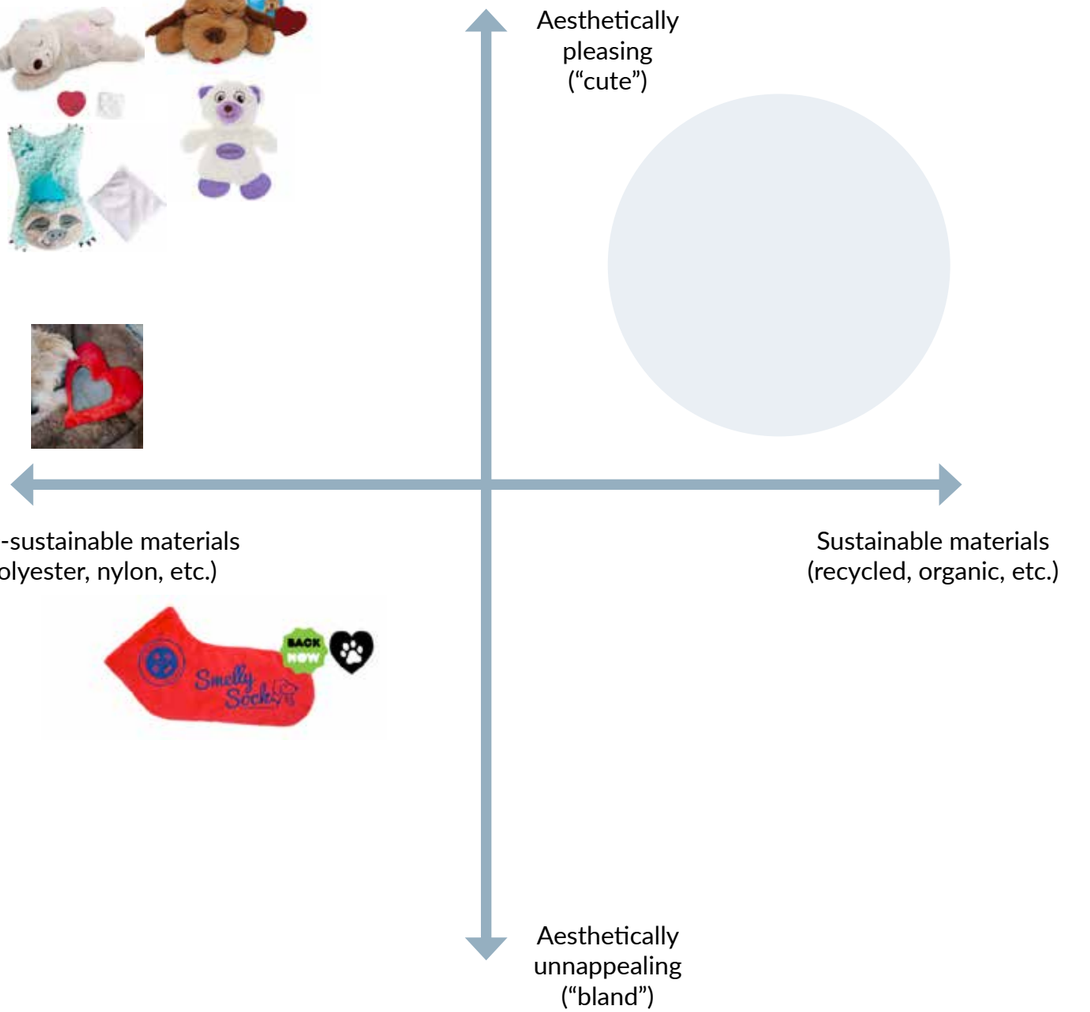
The bottom two right products, the "smelly sock" and the "comfort cuddler," are two dog toys currently on the market that use your used clothing as stuffing with the intent of reducing separation anxiety. With this discovery, I realized my product needs to differentiate from this group. Therefore, I decided to do a biaxial map of the current market with my existing design criteria.

TOUCH & FEEL INDUCED

SMELL INDUCED

MARKET OPPORTUNITY

Since the extraction of raw materials had the highest environmental impact from the initial LCA, I felt that would be a factor in differentiating my product. Therefore, if I made the toy with a single sustainable material, it would be different from the fabric stuffed dog toys and be recyclable. In addition, the existing fabric stuffed toys exhibit no sustainable business model or sense of “character” (face, eyes, nose, etc.), which could help my idea stand out as well since cuteness played a factor in determining the dog owner’s purchasing decisions.



CHALLENGES TO ADDRESS

The final solution will aim to target all aspects of the design criteria while focusing on sustainable materials and cuteness. However, several challenges or issues need addressing. What single material to use for durability, recyclability, and sustainability, how to create an enclosure for the t-shirt stuffed toy without using different types of materials, and how to also cater to the four user personas created of communication, convenience, community, and change.

SINGLE MATERIAL

SUSTAINABLE

What materials have the least amount of impact on the environment?

RECYCLABLE

What materials are easily recyclable?

What is the most convenient way to recycle something?

DURABLE

What materials are considered the most durable?

How much longer would they last than the standard plush dog toy?

ENCLOSURE

What type of enclosure device can be used that is safe and can withstand a dogs chewing?

PLUSH DOG TOY DURABILITY

Before prototyping, I drove around the city of Atlanta and collected dog owner's plush dog toys. These were ones that they considered "destroyed" and would be throwing away next week. The purpose was to understand the weak points in each dog toy. Additionally, to understand the different types of conditions dog toys are in right before thrown away.

It was surprising to see the variability of destruction. However, the commonality amongst the collection of toys was punctured or missing squeakers and missing stuffing.

MISSING APPENDAGES

RIPPED SEAMS

CHEWED APPENDAGES

FRAYED ROPE/EDGES

NO STUFFING LEFT

MISSING SQUEAKERS

PROTOTYPING
ENCLOSURE METHODS R1

Before anything else, I decided to focus on enclosure ideas or mechanisms to seal the toy after stuffing clothing inside. Three things kept in mind were: safety for the dog (avoiding long strings and choking hazards), durability to withstand chewing or playing, and a simple design to be convenient and easy to understand for the dog owner. After prototyping, I narrowed it down to tying mechanisms since they were simple and would keep the clothes inside.

OPEN HOLE




BOTTLE CAP


ELASTIC


TYING MECHANISMS








PROTOTYPING
ENCLOSURE METHODS R2

Rather than sewing by hand, I went to the sewing machine to do a quick test on the drawstring enclosure idea. I used old t-shirts to make the prototype and followed a YouTube tutorial to make a drawstring bag. I then tested the prototype with my advisor's dogs to see if they would like the toy and if the tying mechanism would be durable and safe enough for the dogs. After a few days, the seams ripped open, strings fell off/broke, and the clothing fell out. The prototype was monitored at all times during play, but it was communicated that the owners felt the tie "was a bit dangerous" and it needs to be bigger for better chewing and less chance of choking or swallowing. From here, I decided to focus on making more prototypes with different types of tying or enclosure methods that were more durable, no strings attached, and larger in size.

"The tie was a bit dangerous"

BEFORE

DURING

AFTER

LARGER SIZE

STRONGER ENCLOSURE METHOD

MORE DURABLE STITCHING

REMOVE THIN STRINGS

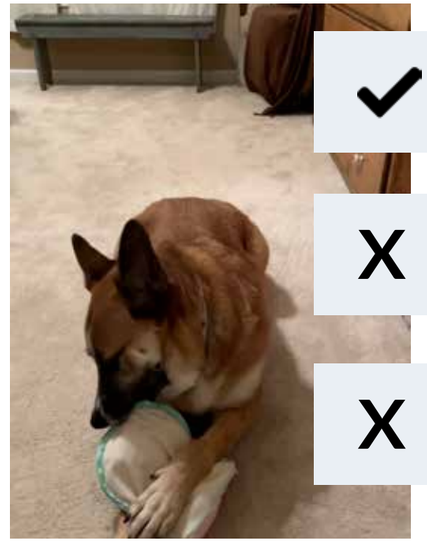
PROTOTYPING
ENCLOSURE METHODS R3

Following the feedback, several more prototypes were made with two different types of enclosure ideas: one without tying and one with tying. To avoid tying, one was made by having a hole in front with the ability to flip inside out. The idea of flipping inside out came from prototyping with t-shirt sleeves inside one another. The one with tying was made by having a hole on top with the ability to tie the hole closed and also flip inside out. However, the “strings” were attached to the main part of the body and were thicker in size to increase durability and safety.

HOLE IN FRONT & REVERSIBLE

HOLE ON TOP & REVERSIBLE

Following the feedback, two different types of enclosure ideas came: one without tying and one with tying. The first one was made by having a hole in the front to flip inside out to avoid tying. The idea of flipping inside out came from prototyping with t-shirt sleeves inside one another. The second one with tying works similarly to a bag. By having the hole on top, it can tie closed. It is still able to flip inside out as well. However, the “strings” were attached to the body and were thicker in size to increase durability and safety rather than being a separate component.



✔ DURABLE

X FUN

X CUTE

✔ DURABLE

✔ FUN

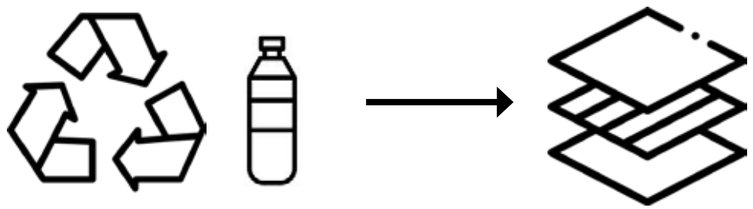
✔ CUTE

CHOOSING MATERIALS

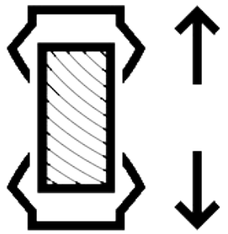
Material choice was next. The choice of material would affect three of my design criteria: recyclability, durability, and sustainability. After researching different types of sustainable materials, I narrowed down my decision to use recycled polyethylene terephthalate (rPET) canvas, aka recycled water bottles. It had the lowest score in terms of Impact Factor Points, is 3x more durable than the standard 65cotton/35polyester plush toy material, and keeps water bottles out of the landfill. Biodegradable or compostable materials are not suitable for this type of application because even though they would be a more sustainable choice, they would not withstand a dog's chewing.

To 3x multiplier was determined by two material properties: strength and fabric weight. According to McCullough (2019), the property differences in rPET versus virgin PET are not significant. They proved through tensile strength, yarn strength, bending rigidity, and abrasion resistance tests that rPET can perform on a comparative level to virgin PET. Therefore, the tensile strength of rPET got calculated through trend forecasting in data sets of poly/cotton blends from several resources (Islam, Yasmin, Alam, Kanon, 2019) (Islam, 2019). With 65% cotton/35% polyester blends being the material choice in dog plush toys, the trend line calculated and compared the tensile strength to 0% cotton/100% polyester. Since polyester and recycled polyester perform at a comparative level, the result determined the multiplying factor by which 100% rPET is stronger than 65%cotton/35% polyester (raw data in Appendix E). From the calculation, it estimates that 100% rPET is 2x stronger than 65/35 blends. Then, to determine the material weight multiplier, a fabric GSM chart was used (see Appendix E). Standard dog plush toys range in the 260 GSM area, whereas rPET canvas ranges in the 290-380 GSM area. GSM (grams per square meter) is the metric measurement of the weight of the fabric. The higher the GSM, the denser and more durable the fabric. Therefore, when taking the averages of medium fabrics compared to medium light and heavy fabrics, it determined, through this chart, that rPET canvas would be about 1.5x stronger than the standard 65% cotton/35% polyester materials used in plush dog toys. Therefore, by multiplying the property strength multiplier (2x) by the material weight multiplier (1.5x), 100% rPET canvas is about 3x more durable than 65/35 poly/cotton blended fabrics.

I also had additional confidence in choosing rPET because when looking at a range of possible fabric materials, rPET had the lowest score from Okala Impact Factors (see Appendix E). Bamboo, however, is not considered a viable option because it is not as strong as synthetic fibers and not widely available.



100% rPET canvas



MATERIAL WEIGHT **X** **PROPERTY STRENGTH**

3X

Stronger than
65% Cotton/35% Polyester Fabric

RECYCLABILITY OF 100% RPET

The next challenge was recyclability. By calling Waste Management, I found out that even if the dog toy materials are 100% rPET, it would still not process and get sorted through correctly because it is inherently still a fabric and would not be recognized by the machines. I then thought about other shipping methods. If the dog toy came with a shipping package, it would go against my single material design criteria. But if the dog toy could be the shipping vessel itself to send to a textile recycling plant, it would adhere to my single material design criteria. After calling USPS, their main concerns were the scannability of the barcode and the dimensions of the "dog toy package." Therefore, I decided to do testing myself.

WASTE MANAGEMENT

Q: "If a plush dog toy was made out of 100% recycled water bottles (rPET), can it be thrown into residential recycling bins?"

A: "No, because during the sorting process at recycling plants, they will only recognize it as a fabric and could easily get tangled up in the machines. "

Textile recycling plant

Residential recycling bins

UNITED STATES POSTAL SERVICE

Q: "Can a piece of fabric be shipped through the mail?"

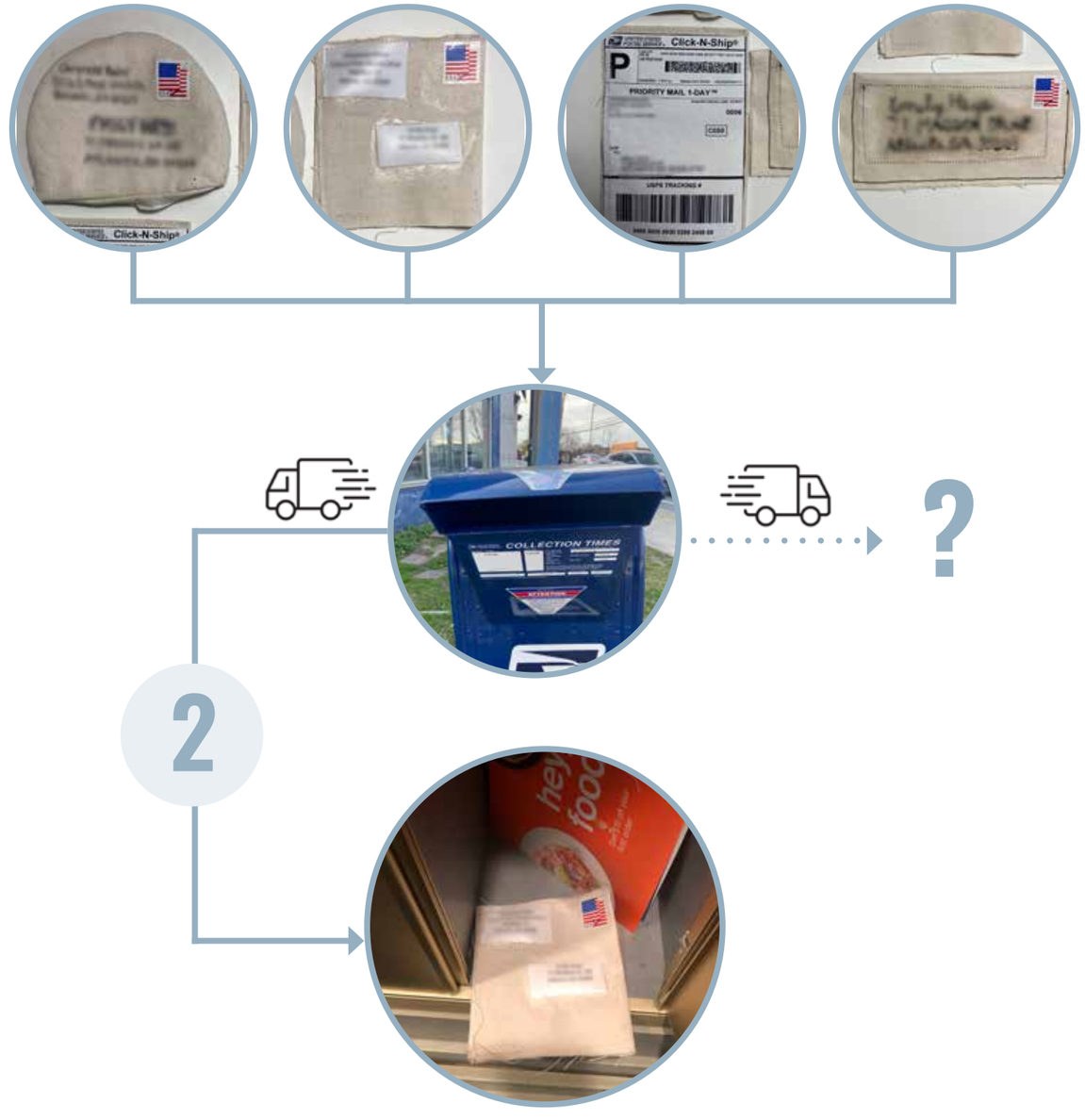
A: "Typically, we require paper. But if it is a fabric, it needs to meet all required standards and dimensions and the shipping label needs to be scannable."

Shipping fabrics through mail

Unreadable barcode

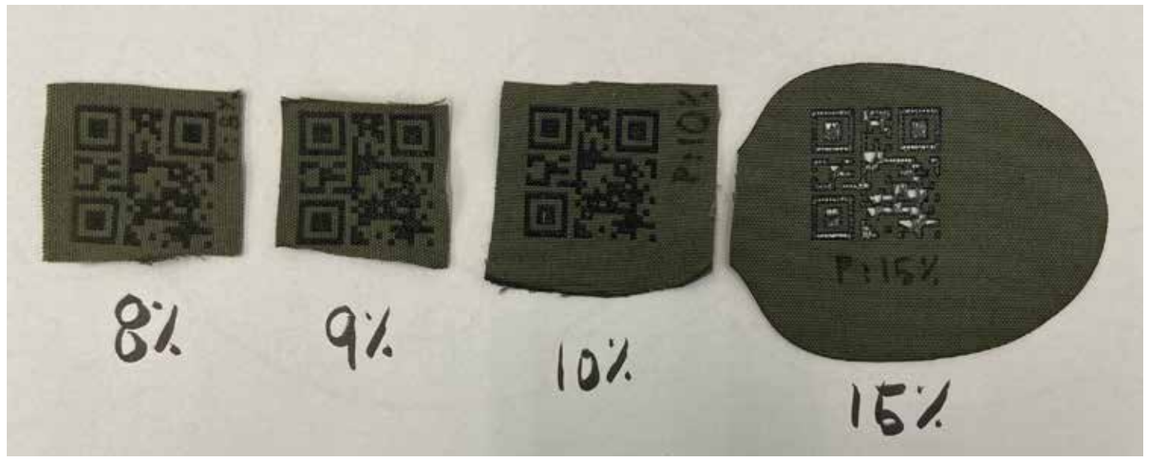
TESTING MAIL-ABILITY OF FABRIC

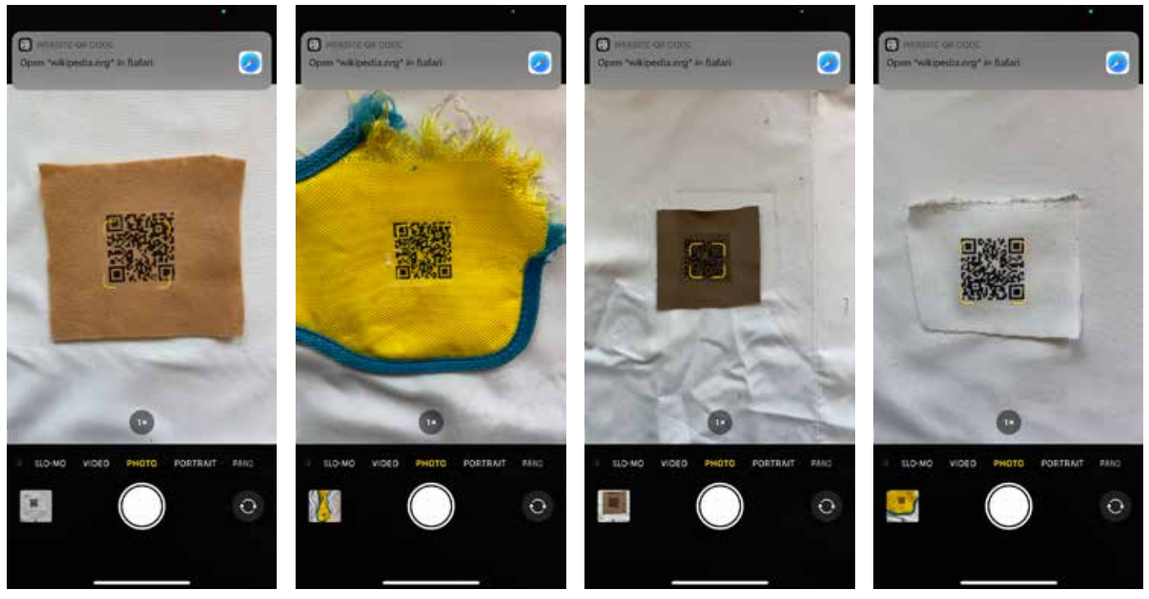
To see if USPS can ship a piece of fabric through the mail, I decided to create four different samples to see if they would arrive at my friend's address. Four prototypes were a cotton canvas fabric in a standard envelope form and one with a paid USPS label placed on top. For the envelope samples, I decided to try different methods with each. One was non-rectangular in shape with a handwritten address, another one was rectangular with addresses ironed on, and another one was created without a return address but the mailing address was created by sewing the address on using thread. To ensure the paper labels and stamps stayed on, I used a DIY method for creating iron-on transfer sheets. After placing all four in the mail at the same time, it was found that sample number 2 successfully made it to my friend's mailbox. Therefore, it was confirmed that mailing a piece of rectangular fabric that correctly followed envelope standards are able to be shipped through USPS.



TESTING SCAN-ABILITY OF FABRIC

Even though the printed USPS label did not make it through, I still wanted to test if a shipping label was scannable on a piece of fabric without using paper to stick to my single material criteria. Several tests were done by laser-cut etching at different power levels a business reply mail layout to see if the contrast between the burn marks and the fabric would be scannable. Through conversations with the Mailpiece Design Analyst at USPS, I found that their engineering department was not currently taking samples due to COVID. Therefore I decided to test this method myself by laser-cut etching a QR code on fabric instead. After multiple attempts, I found that scannability did not work with a laser-cut etched QR code. However, I then decided to try a different method of using iron-on transfer sheets onto the fabrics to see if that would be scannable. And it worked. Because the iron-on transfer sheets required melting a form of plastic onto the fabric to make it stick, if possible, I would desire the melted plastic to be a form of rPET to make sure it is still able to be recycled. If not, I would hope to utilize screen printing or printing directly on the fabric itself with natural-based inks as another alternative.

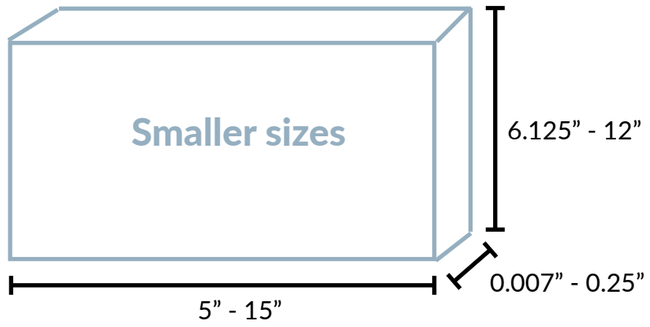




I tested the iron-on sheet transfers with four types of fabrics (from left to right), all with varying colors: rPET fleece, polyester canvas on an existing dog toy, cotton canvas, and bamboo fleece. The lighter colored fabrics (white and yellow) were much easier to scan than the darker colored fabrics (light and dark brown). Lighter-colored fabrics provided the highest contrast for scannability, and therefore would be better to use for the final design.

STANDARDS FOR BUSINESS REPLY MAIL

When talking with the Mailpiece Design Analyst from USPS, she sent over documents regarding the business reply mail (BRM) format guidelines. For the recyclability of the dog toy to be as convenient as possible for the dog owners, it must adhere to these guidelines. In addition, the size of the toy must be rectangular and meet the following dimensions:



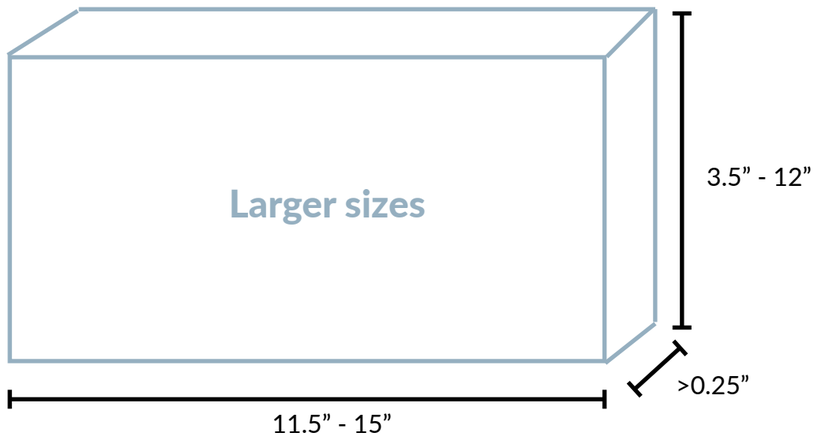
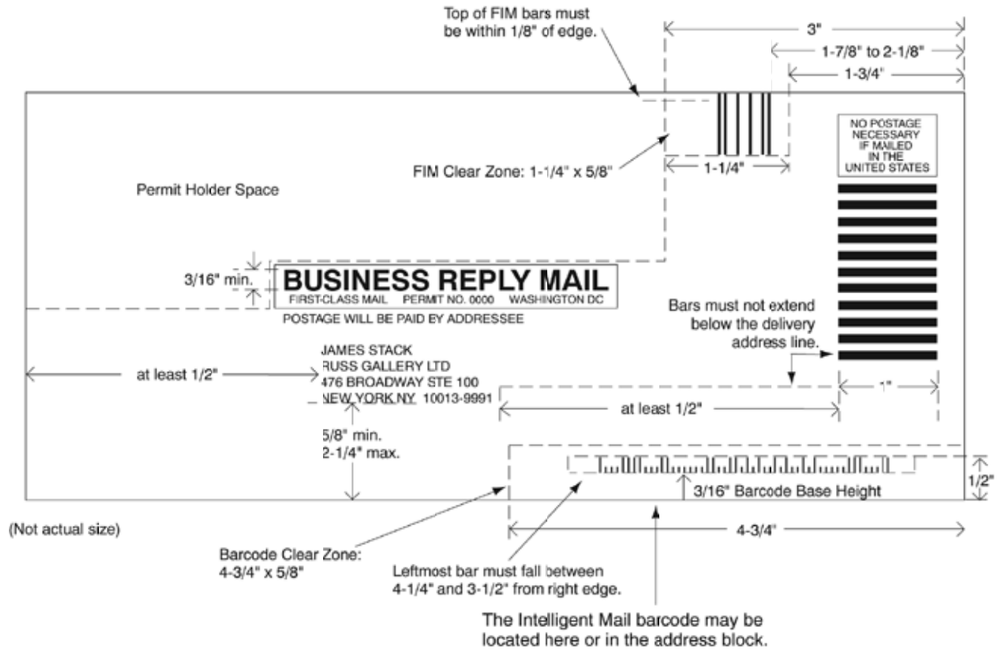


Exhibit 1.5.1 Business Reply Mail Format



1.5.2 Printing and Print Reflectance

All forms of printing are permissible if legible to the satisfaction of the USPS. Handwriting, typewriting, and hand stamping may not be used to prepare BRM. Printed borders are not permitted on letter-size BRM, but are permitted on envelopes greater than 6-1/8 inches high or 11-1/2 inches long or 1/4 inch thick. All ink colors are acceptable if the piece meets the appropriate reflectance standards in 204.1.3.

1.5.3 “No Postage Necessary” Imprint

The imprint “NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES” must be printed in the upper right corner of the address side of the piece, except as allowed under 601.6.5 for reusable mailpieces with outgoing permit imprint indicia. The “NO POSTAGE NECESSARY” imprint must not extend more than 1-3/4 inches from the right edge of the piece.

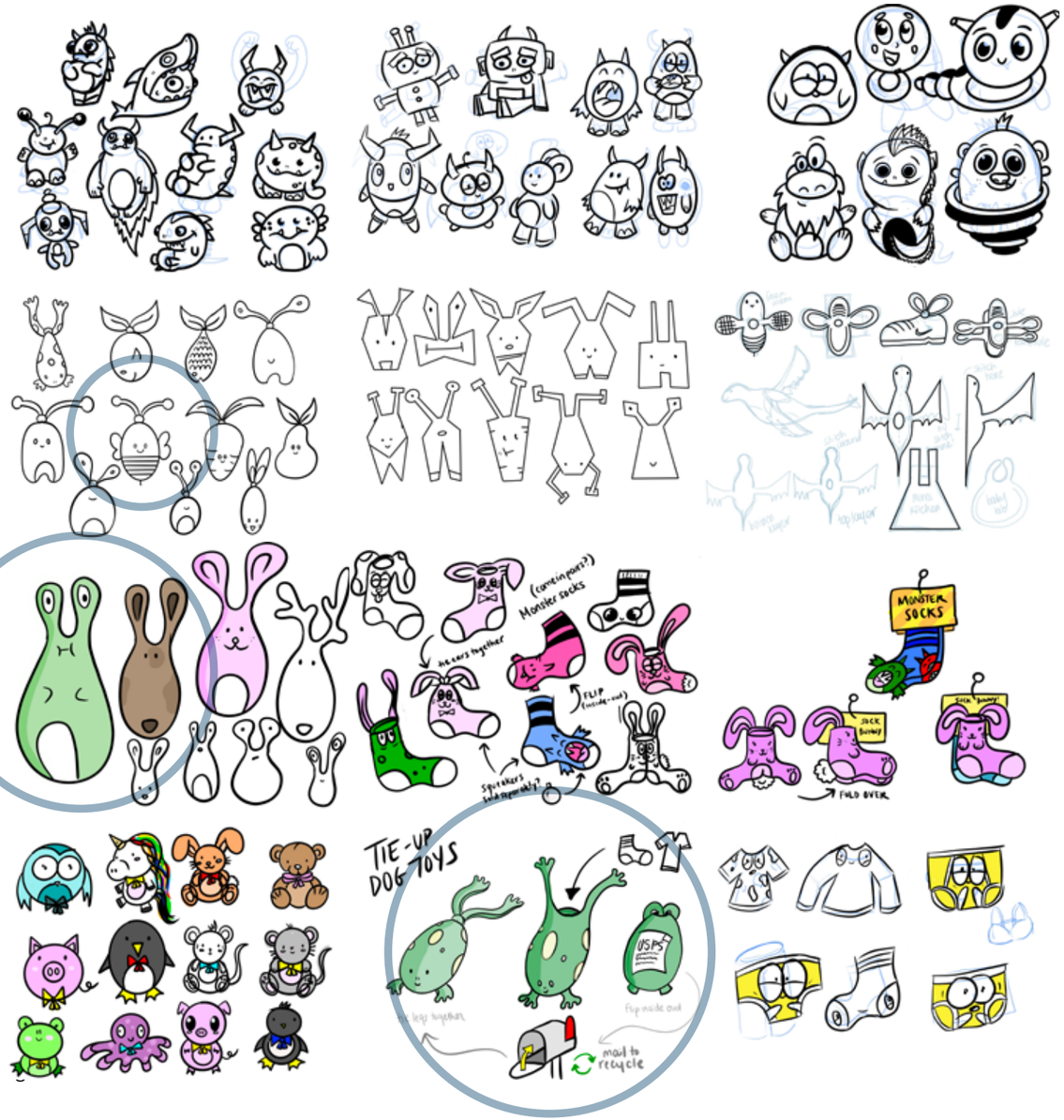
1.5.4 Business Reply Legend

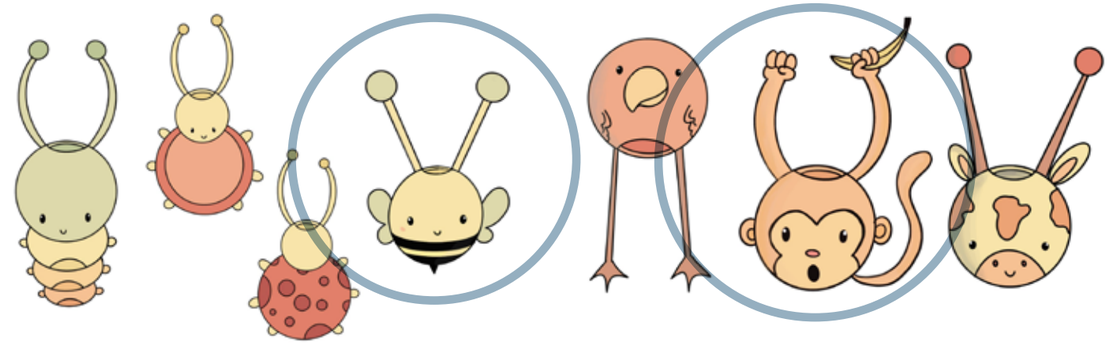
The legend “BUSINESS REPLY MAIL” or “BUSINESS REPLY LABEL”, as appropriate, must appear on all pieces. This legend must appear above the address in capital letters at least 3/16 inch high. At the permit holder’s discretion, the business reply legend may be surrounded by a rule or border.

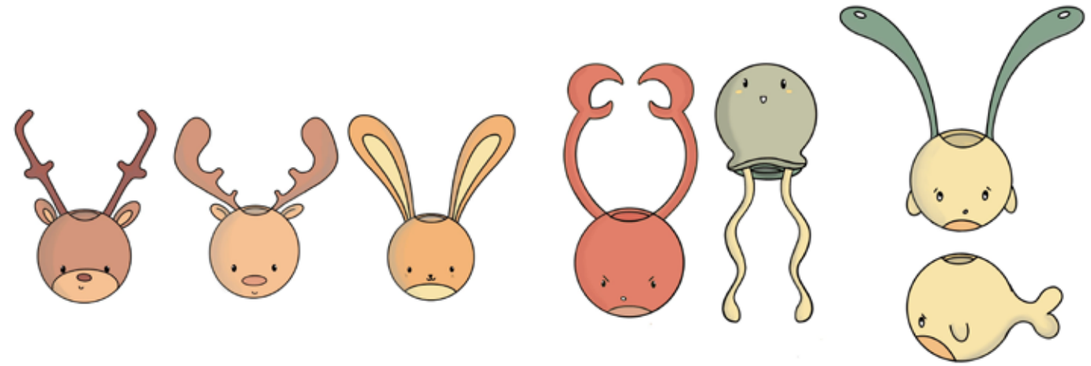
DELIVER

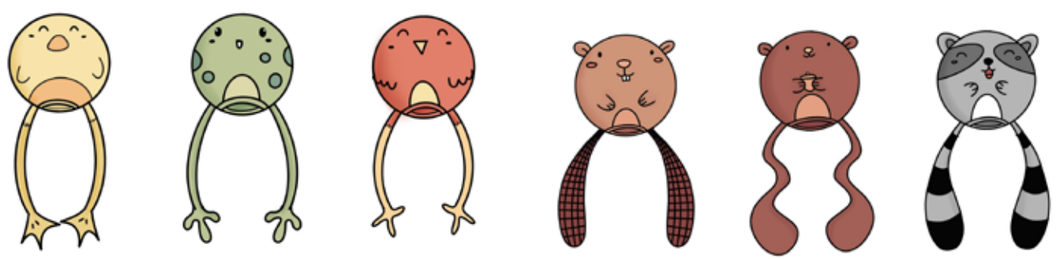
SKETCH IDEATION FOR FINAL PROTOTYPE

With all data gathered regarding material choice, how to ship a piece of fabric, and the type of enclosure mechanism best suited for the dog and dog owner, I brainstormed character ideas to match the desired “cute” aesthetic from one of my top design criteria.







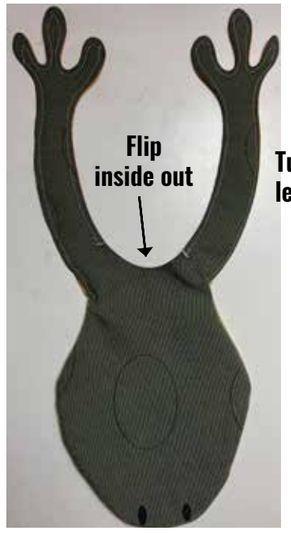


FINAL PROTOTYPING

After a third and final round of testing with my advisor's dogs, the prototype was much more successful. They were interested in chewing on the knot and the tying mechanisms of the toy, it was durable, and it was at a better size. Therefore, providing the confidence to move forward with the concept.



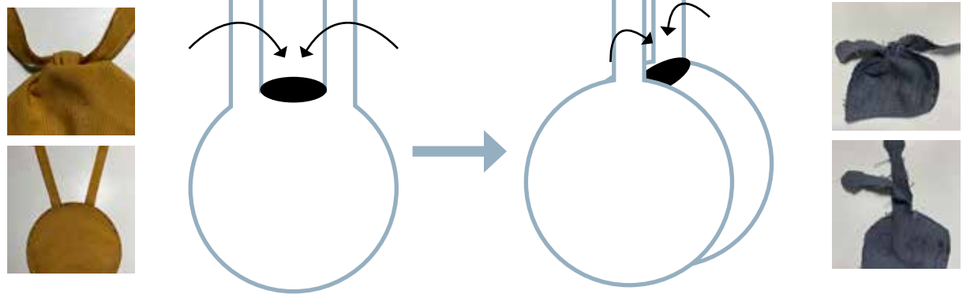
Moving forward, I started to develop more of a character into the design. I utilized the tying mechanisms to act as the "legs" of a frog. I drew out the design in Adobe Illustrator and used the laser cutter to have precise cuts when sewing the pieces together. It also helped to singe/burn the edges to avoid it from fraying easily.



PROBLEMS TO SOLVE

1

Tying the legs together creates a "bunching" that happens near the knot that can distort the visibility of the character design. Rotating the tying mechanism at 90 degrees solved this issue and also made the tying mechanism easier.



Before After

2

When the appendages get tucked inside the hole, there is a concern about them falling out during the shipping process. Therefore, I created an extra flap to flip over the hole to solve this issue (similarly to a pillowcase flap).


Flip inside out

Tuck legs in


Pull flap over hole

Reveal shipping label

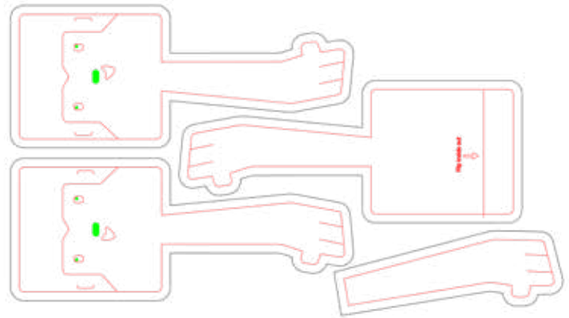
3

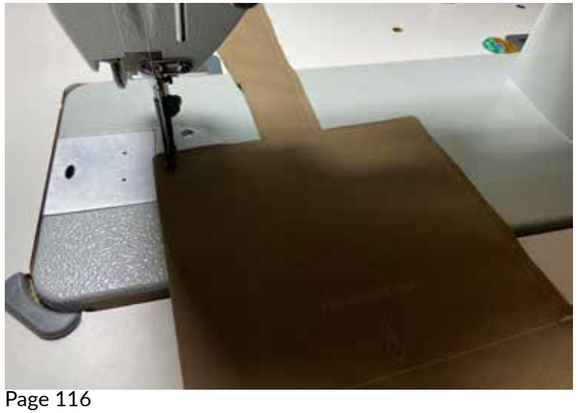
With the inclusion of squeakers, the toy is more interactive. Since squeaky dog toys were the favorite amongst dog owners, it makes sense to include these items. Therefore, I enclosed one squeaker within each appendage or "leg."


Squeakers placed inside the two ties

FINAL PROTOTYPE

The final prototype must be rectangular to fit the required dimensions of the BRM guidelines. All in all, this would be the final prototype to test with dog owners for their feedback.





Stuffing the toy with your used clothing

Place toy in front

Place clothing inside

Fluff it up

Tie simple knot with the “arms”

Flipping it inside out to reveal the BRM label

Flip inside out

Tuck arms inside the hole

Pull flap over the hole

Reveal BRM label and place in mailbox

TESTING PROTOTYPES WITH DOG OWNERS

Unfortunately, I did not receive approval in time from IRB and the IACUC to perform studies involving dogs. Instead, I decided to perform task and evaluation assessments of the dog toy prototype with seven female millennial dog owners. This study involved dropping off the prototype at their home, having them get on an online video call with me, and then asking them to perform tasks and answer questions regarding their experience with the prototype. The evaluation assessment included nine questions on a Likert scale from one to five, with one being “strongly disagree” and five being “strongly agree.” Raw data is in Appendix C. The responses from the assessment were averaged and are on the next page. Every category ranked four or higher except for the question in regards to durability. Some dog owners were hesitant on this question because they were unsure of what type of material the final design would have. They did really like the canvas feel because it felt durable but were still not confident in answering. Therefore, their responses were closer to neutral (3). Overall, 100% of dog owners said they would be willing to buy the toy, and, therefore, the prototype successfully met one of my research questions.

CONVENIENCE

All dog owners strongly agreed that the shipping method for the toy was convenient because it did not add any extra steps. The prepaid postage printed on the inside of the toy was of high interest because it made recycling the toy easier, and dog owners felt good about helping the planet.

SAFETY

Dog owners also strongly agreed that they thought the toy would be safe for their dog since it did not have any polyfill stuffing inside and voiced no concerns regarding choking or ingestion hazards.

RECOMMENDATIONS

Many dog owners found the toy to be positively different from other toys out on the market. During the evaluation, they immediately thought of friends or family members who they would call “environmentally-conscious” and know that they would enjoy a toy like this for their dog. They would either recommend it to them or buy it for them as a gift instead.

WILLINGNESS TO PURCHASE

Six out of seven dog owners strongly agreed they would buy this toy for their dog because they knew their dog would like it (had squeakers) and several other factors regarding convenience, recyclability, and durability. However, many did voice their concern about the price. On average, dog owners said they would be willing to purchase the toy if it was around $18.

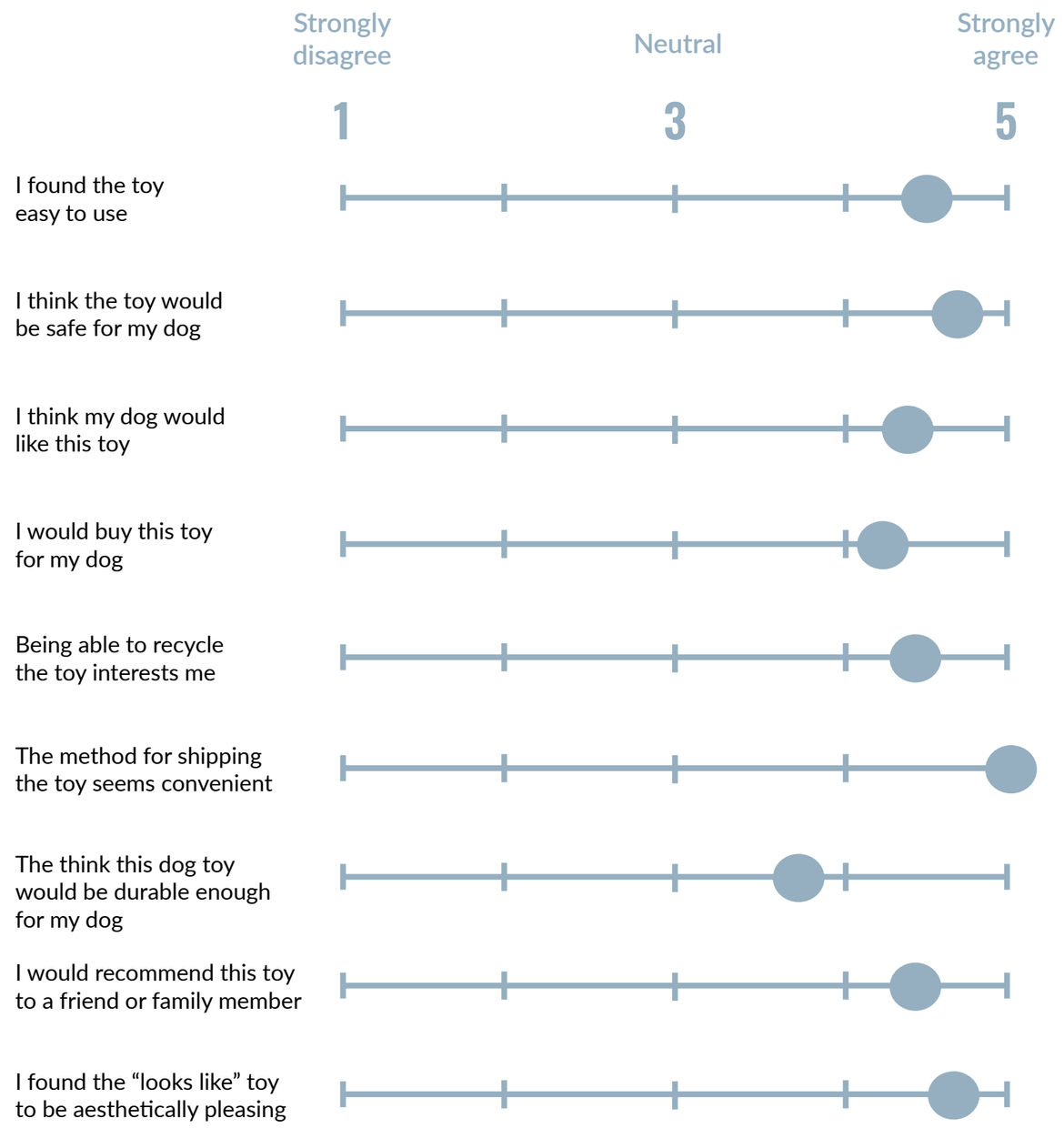
EASE OF USE

The method for inserting the clothing in the toy and flipping it inside out to be shipped to a textile recycling planet was easy for dog owners to use and understand, as long an instruction sheet is provided.

AESTHETICS

Dog owners enjoyed the color palette and facial features of the “looks like” prototype. However, with the “works like” prototype, dog owners wished the face contrasted better against the material and included brighter and fun colors.

RESULTS FROM ASSESSMENT



FEEDBACK FROM DOG OWNERS

"WOW, THIS IS A REALLY COOL IDEA. MY DOG WOULD GO NUTS FOR THIS!"

"IF I BOUGHT TOYS - THIS WOULD BE A TOY THAT I WOULD BUY"

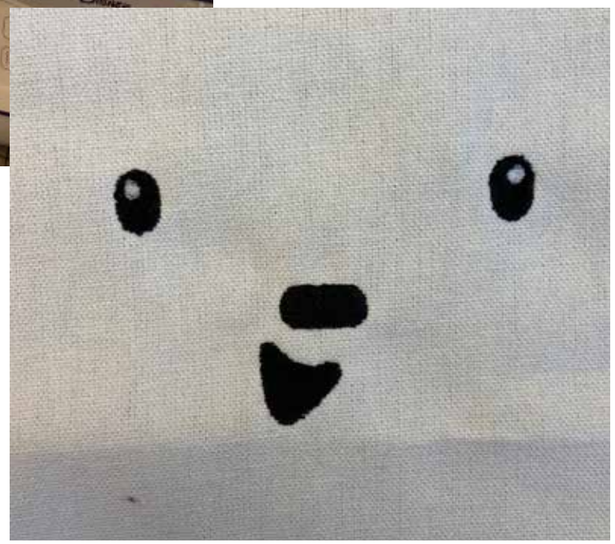
SUGGESTIONS FOR IMPROVEMENT

Overall, dog owners enjoyed the prototype and loved the story and service model behind it. By putting their clothing inside as "stuffing," they viewed it as much safer for the dog than polyfill that comes in a standard dog plush toy. Interestingly, however, dog owners were more attracted to the convenience of recyclability rather than the reduction in separation anxiety for their dogs. The prepaid BRM (business reply mail) shipping label already printed on the inside of the dog toy prototype created a higher reaction than the used clothing that reduces their dog's separation anxiety. It was convenient, simple, and did not add any extra steps to their lives. Dog owners voiced they probably would not take the time to print out a shipping label or get a stamp to send it through the mail if it was not a prepaid BRM label. In addition, one dog owner said they stopped buying dog toys because they "just get torn up and then there is plush everywhere that I have to clean up." But the fact that this idea includes no stuffing and can be recycled made it attractive enough to where the dog owner would want to buy it for their dog. From the interviews, however, there was still plenty of room for improvement in the overall design. The most consistent requests or comments are below.

1. Provide instructions with the toy so I understand how to use it
2. What happens if the label gets destroyed? Will the label stay in tact during play?
3. Offer it in three different sizes: small, medium, and large
4. Longer arms to play tug of war and to tie a double knot
5. More bright and colorful (more fun)

FINAL DESIGN

After collecting and analyzing all the feedback, I made a final prototype that incorporated the suggested changes from my interviews. An important aspect was adding more contrast in the facial features and color make it cuter. I did this by utilizing the contrasting colors of black and white on an embroidery machine to make the facial features: the eyes, nose, and mouth. I then added the color blue around the face to make it contrast. In addition, I made the legs about four inches longer to accommodate dog owners that wanted to use it to play tug of war after tying it with a double-knot. All other aspects kept the same.



me Remy

THE MOST CONVENIENT RECYCLABLE DOG TOY!

BUSINESS MODEL

Recycle Me Remy is a sustainable dog toy that follows a circular economy business model. A circular economy is an economic system aimed at eliminating waste and the continual use of resources. The circular model builds economic, natural, and social capital. It is based on the three principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

In an analysis of case studies, the Ellen MacArthur Foundation has identified the following four essential building blocks of a circular economy (What is the circular economy, 2017):

1. Circular economy design

   There is a need to facilitate produce reuse, recycling, and cascading. Areas for economically successful circular design include material selection, standardized components, durable products, easy end-of-life sorting, separation or reuse of products and materials, and design-for-manufacturing.

2. Innovative business models

   The shift to a circular economy requires innovative business models that either replace existing ones or seize new opportunities. Companies with significant market share and capabilities along several vertical steps of the linear value chain could play a vital role in circular economy innovation and driving circularity into the mainstream by leveraging their scale and vertical integration.

3. Reverse cycles

   New and additional skills get needed for cascades and the final return of materials to the soil or back into the industrial production system. These include delivery chain logistics, sorting, warehousing, risk management, power generation, and even molecular biology and polymer chemistry.

4. Enablers and favorable system conditions

   For widespread reuse of materials and higher resource productivity to become commonplace, market mechanisms will need to: play a dominant role, supported by policymakers, educational institutions, and opinion leaders. Collaboration, rethinking incentives, providing a suitable set of international environmental rules, leading by example, and driving upscale fast, and access to financing are examples of enablers.

Recycle Me Remy's take-back program aims to be sent directly to a textile recycling facility. Therefore, it closes the loop and eliminates the current take-make-waste business model. Currently, toys are being bought, used, destroyed, disposed of, and then go to landfills. But this new sustainable toy will now be conveniently sent to a textile recycling facility at its end of life to reclaim the materials and make them into new toys.

In an ideal business model, the textile recycling facility would also be the same building where the toy gets manufactured and the location of the design team. Therefore, creating a continuous feedback loop of improving the design. When the toy is received, the design team can analyze the areas on the toy that got ripped or destroyed the most to improve the design. For example, if many toys had ripped-off legs, the design team would design a stronger seam where the legs are attached to the main body.

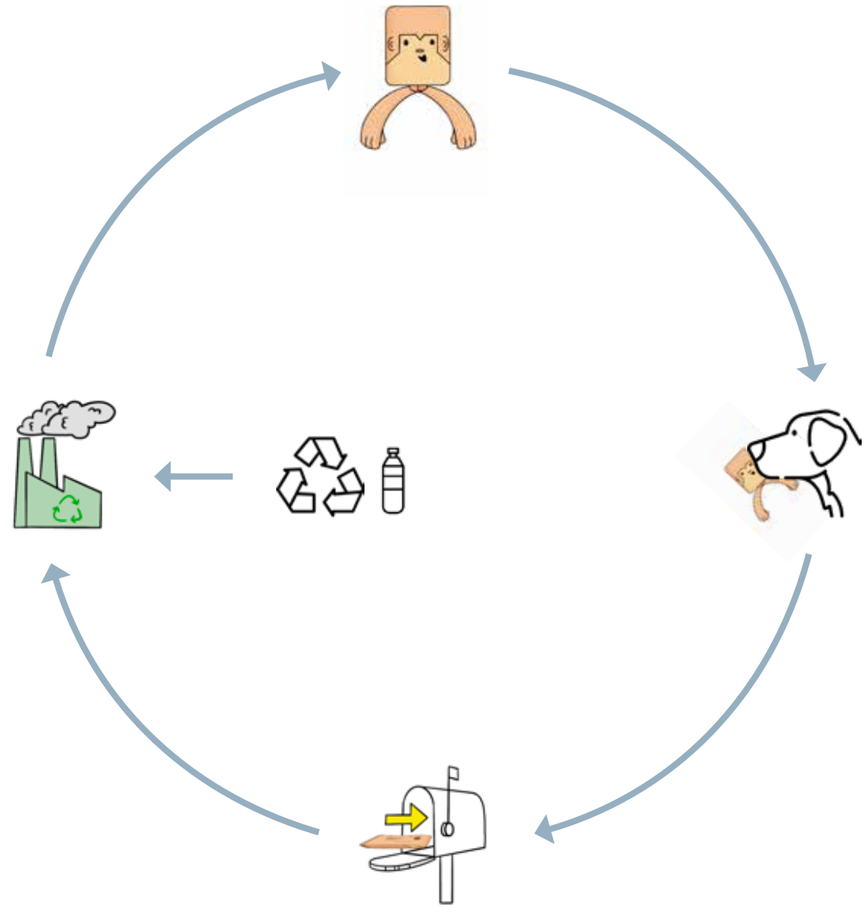
Recycle Me Remy meets all four building blocks of a circular economy because:

1. It facilitates product reuse of t-shirts and product recycling through the prepaid business reply mail label located on the toy. Additionally, it uses materials made from recycled water bottles (rPET), designed for easy end-of-life sorting, and made from only one material.

2. It replaces the current take-make-waste business model that drives circularity.

3. The business model integrates a convenient take-back system to return the materials into the industrial production system.

4. It rethinks the incentives of recycling. First, it easily enables dog owners to place the worn-out toy in their mailbox. Additionally, they will receive a discount on their next purchase after it ships to the company.



COSTING & PROFIT MODEL

From the evaluation assessments, dog owners were willing to pay, on average, $17.99 for the dog toy. However, to meet both the economic pillar of sustainability and profitability in the triple Venn Diagram, comparisons and estimates with competing products are done.

Competing products that use 80% or more of materials made from recycled water bottles and within a similar size as ‘Recycle Me Remy’ got ranked by durability on the next page. ‘Recycle Me Remy’ falls under the ‘Large’ category of competing products. Additionally, toys with a canvas-like material are more durable than soft plush materials. Therefore, the red monkey and green sea turtle get listed towards the top. The blue sea turtle is listed next because it has a binding all around its edges, making it more durable even though it is still soft plush.

Looking at the price, size, and durability of competing products, ‘Recycle Me Remy’ fits within all three categories on the top row (see right). The average price dog owners were willing to pay for the toy ($17.99) is less expensive than its competitors. This is important since dog owners would only pay within a few dollars more for a competing toy. To then understand its profit margin, the cost to manufacture the toy gets estimated.

The highest prices will come from its recycled materials and a business reply mail (BRM) permit. Getting a BRM label requires an annual fee of $160 and costs roughly $0.65 per package. However, the cost to fully make the toy is unclear until an estimate gets returned.

Overall, it is with confidence that since ‘Recycle Me Remy’ falls under a similar range of pricing for sustainable and durable toys, it will have a similar profit margin. Since it does not have any stuffing and has a less complex design, those aspects could balance the cost of adding a BRM label. However, the exact profit margin is currently unknown until more information gets collected from manufacturers.

HIGHER DURABILITY

$17.99
22”x7”x0.25”
38.5in^3

$18.99
11”x12”x4”
528in^3

$19.99
11.5”x11”x3”
379.5in^3

$19.99
11”x10”x3”
330in^3

$12.99
10”x10”x3.5”
350in^3

$12.99
10”x6”x4”
240in^3

$12.99
11”x9”x4”
396in^3

$18.89
14”x3”x4”
168in^3

LOWER DURABILITY

SHIPPING

The process is simple. Once the dog gets done playing with the toy or it has reached its end of life, the owner should follow the 6 step process below: untying the toy, flipping it inside out, tucking the arms inside, revealing the extra flap cover, flipping it over the hole to prevent the appendages from falling out during shipment, and then revealing the business reply mail label. Finally, the owner can conveniently put it into their mailbox to ship to a textile recycling facility.

Untie toy

Flip inside-out

Tuck arms inside

Reveal flap

Pull flap over hole

Reveal shipping label

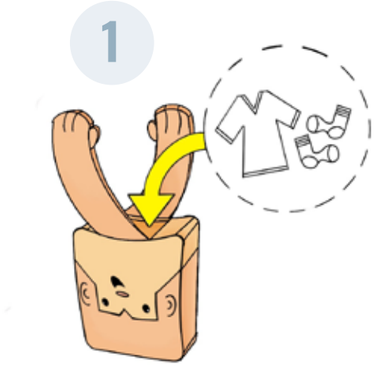
STUFFING

Since the toy comes without stuffing, owners will need to stuff the toy themselves with their used clothing (or anything they don't mind getting a bit dirty or possibly damaged). The process works similarly to a bag. First, push the used clothing through the hole opening between the appendages of the toy and then tie a double knot with them to ensure the clothes won't fall out during play.

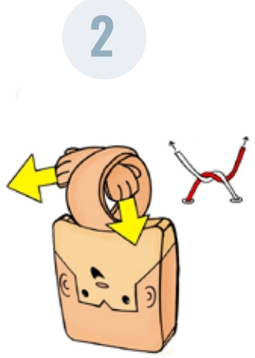
INSTRUCTION MANUAL

During the prototype evaluations with dog owners, many expressed the desire for an instruction manual to guide them through step-by-step on using the toy. I would hope to include these instructions on the back of the packaging that typically comes with a dog plush toy. One set of instructions would explain how to stuff your toy with your used clothing, and another would explain how to recycle your toy once it has reached its end of life.

HOW TO STUFF YOUR TOY



1 Place used clothing inside the hole

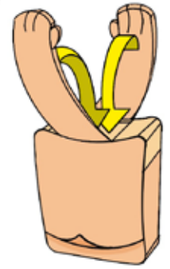


2 Tie arms together into a double knot

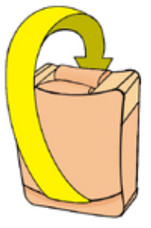
3 Done!

HOW TO RECYCLE YOUR TOY

1 Flip inside out

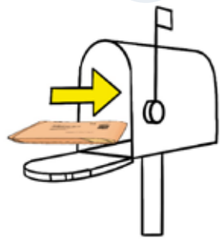


2 Tuck arms inside the hole



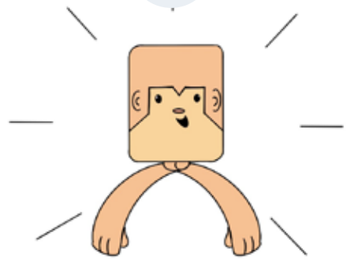
3 Pull flap over hole

4 Reveal shipping label



5 Place inside mailbox

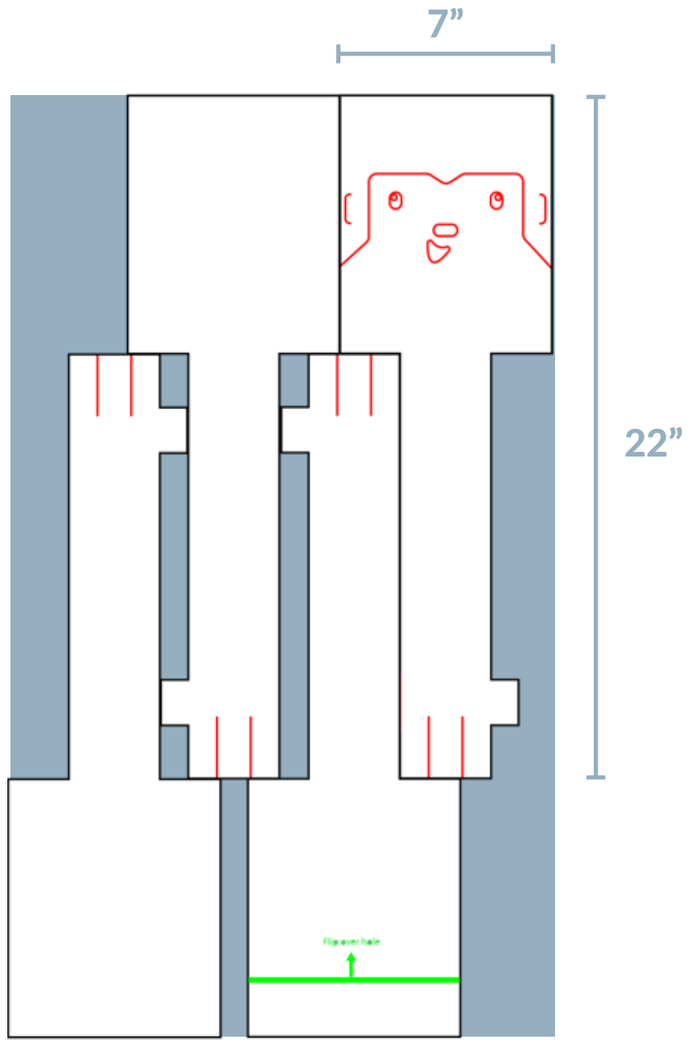
6 Toy sent to textile recycling facility



7 Receive a new toy!

LAYOUT & CUTTING PROCESS

For efficiency, the toy cut out nests within each other to minimize scrap pieces. One toy is equivalent to the four shapes shown below. Multiple toys can then continue to be nested together on one rectangular sheet of fabric. In the future, I hope to create a better layout to minimize the amount of scrap leftover.



FITTING USPS SIZE & DIMENSIONS

According to USPS, one of their sizing restrictions is within the ranges of L: 5” - 15”, H: 3.5” - 12”, W: 0.007” - 0.25”. The sizing of my redesigned dog toy fits within those ranges and adheres to all of BRM guidelines. However, since USPS is currently not taking samples to process through engineering, I cannot know if it will pass their guidelines. But it can be inferred that it would from my previous testing of successfully scanning a QR code on fabric and shipping fabric through the mail.

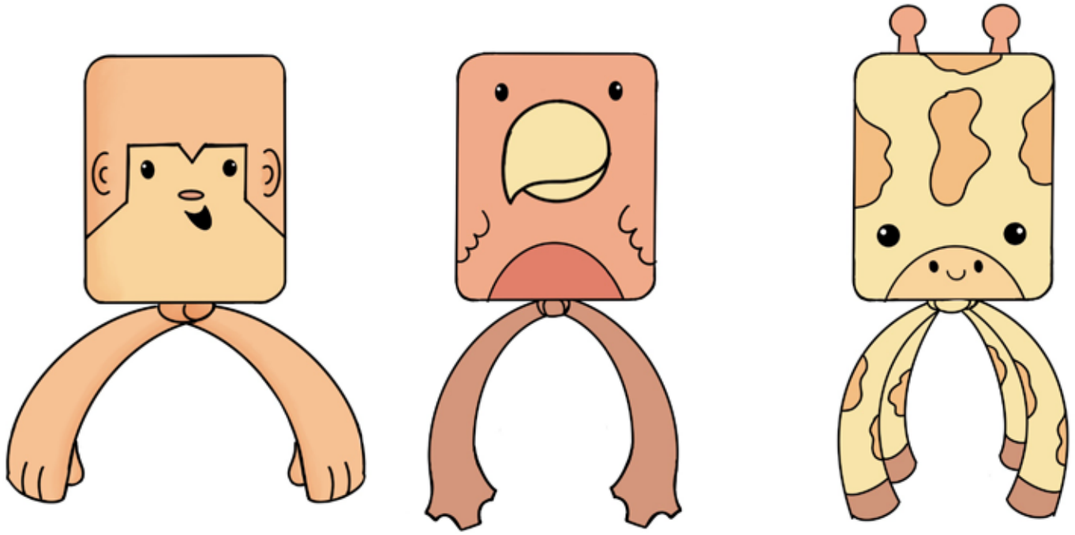
TOP

FRONT

SIDE

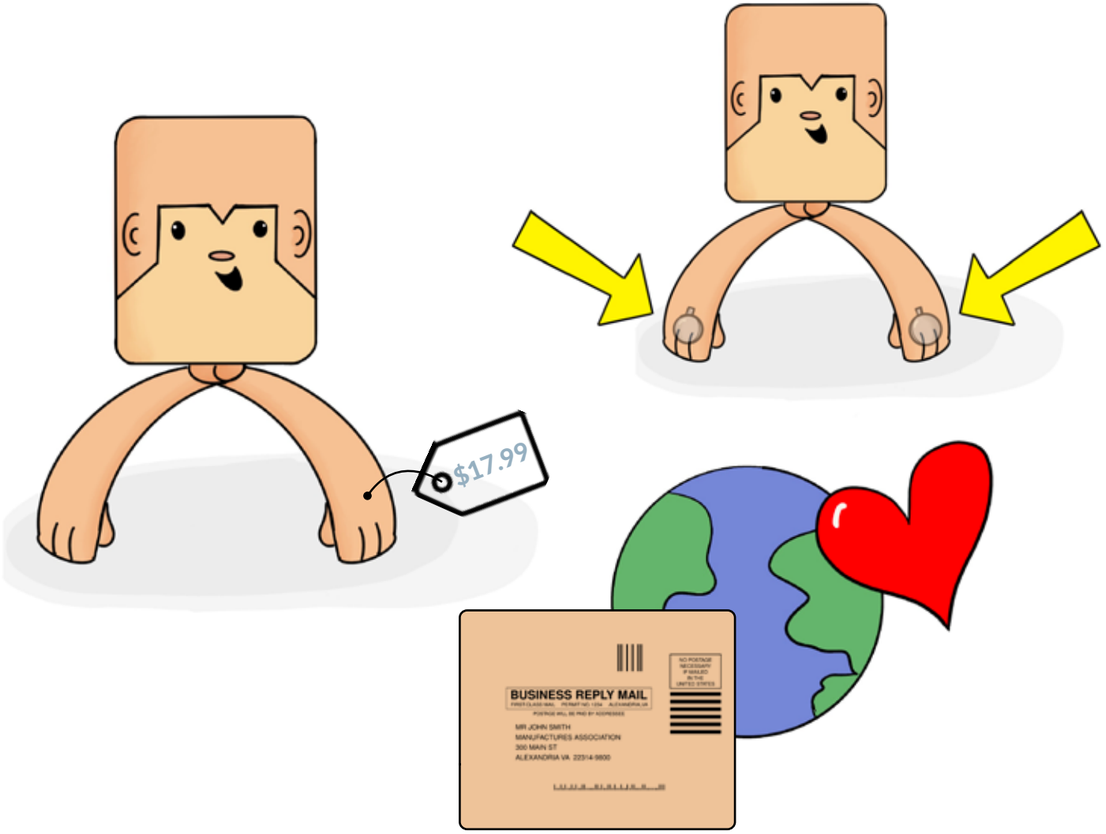
LINES OF CHARACTERS

As with all toy design, I hope to offer a line of characters to cater to multiple audiences. The first line is a trio of zoo animals: a monkey, flamingo, and giraffe. Initial feedback from dog owners seemed to enjoy the monkey and the giraffe the best. They liked the horns on the giraffe because they could be extra “chew zones” for the dog and the four legs offered more opportunities for tug of war. Varieties of characters could then be designed in different styles or sizes, ranging from small to large.



PRICE & MARKETING

Because this toy has many great features, the marketing aspects would need to be concise to avoid overwhelming the consumers when viewing the toy. Initially, it was unclear whether the toy should market as a separation anxiety toy or a recyclable toy. But after many interviews with dog owners, it was made clear that the convenience of recyclability and the inclusion of squeakers was what “sold” them. If this were to go to market, it would need to have the business reply shipping label in view to show how easy it is to put the toy in your mailbox to recycle at a textile recycling facility. Additionally, the price should be around eighteen dollars. When asked what price dog owners would be willing to pay for the toy, eighteen dollars was the average response.



OPENLCA CALCULATION

A life cycle assessment will determine if my redesigned dog plush toy has a lesser environmental impact than a standard dog plush toy through a program called openLCA. A life cycle assessment will assess the environmental impacts associated with all the stages of the toy's life, from raw material extraction through materials processing, manufacture, distribution, use, and then to landfill. OpenLCA is open-source and free software for Sustainability and Life Cycle Assessments. It can provide fast and reliable calculations and identify the drivers of environmental impacts throughout the life cycle by process, flow, or impact category. However, a fully complete LCA can take many years to complete. The initial LCA using Okala Impact Factors is a light-weight version and utilizing this software is just a step above from that since a collection of aggregated data will be used for calculating material durability and electricity usage. Many assumptions will be made as well for the sake of time.

To conduct the LCA, the functional unit and weights of all of the components need to be determined. The functional unit is "providing safe entertainment, mental stimulation and appropriate chewing outlet for pet dogs of all sizes for a service life of one year." The weights of the dog toy components were then taken.

I first began by talking with experts in the pet industry to determine the standard dog plush toy or one that seems to accumulate consistent purchases per month. In the LCA, this would be the baseline toy. Ducks and squirrels, or typical animals found in nature that a dog would see, are the most popular because the structure and colors of these animals are well-known to the dog and are more recognizable. To determine its impacts, I took apart the toy and weighed each item it contained: polyfill stuffing, one squeaker, and the overall fabric shell. The thread used to sew the toy together, however, was estimated. But to calculate the impacts of electricity usage from the sewing machine and cutting process, the seams were measured in terms of linear inches.

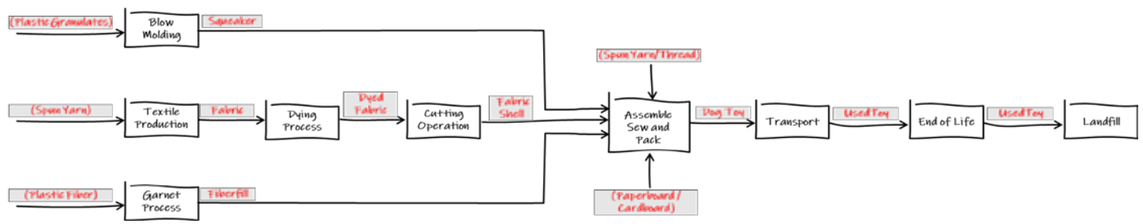
To assess my redesigned toy, I utilized all the same metrics as the baseline toy but with a few more calculations. Since I did not have access to rPET canvas at the time to create my prototypes, I was not able to weigh each part directly. Therefore, I found the material I would want to use on Alibaba with a material properties chart to calculate its overall weight. I multiplied the GSM (g/m2) by the square meters of material used to find its weight in grams. In addition, to find the impact from electricity used by the sewing machines and cutting process, linear inches were calculated by tracing each shape used to make the prototype. The results of the calculations can be found in Appendix F.

Simplified process flow diagrams for both the baseline toy and redesigned toy were then created and are on the next page. More details in Appendix G. Overall, they both have the same overall structure, but the redesigned toy does not include fiberfill or go to the landfill since it will be sent to and recycled by a textile recycling facility.

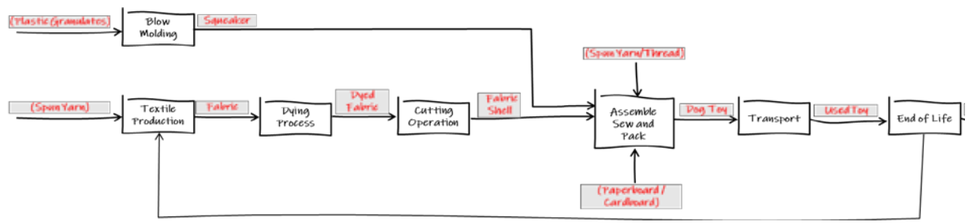
Finally, to perform the LCA, the 3x multiplier calculated on page 99 (indicating that rPET canvas is 3x stronger than poly/cotton blend fabrics) became a crucial part of the LCA. Assuming the baseline toy lasts for one month, this means that it takes 12 of the baseline toys to equal the lifetime of 4 of the redesigned toys during the service life of one year. The weights of the components from the baseline toy were then multiplied by 12. And the components from the redesigned toy were multiplied by 4.

VS

BASELINE TOY PROCESS DIAGRAM



REDESIGNED TOY PROCESS DIAGRAM



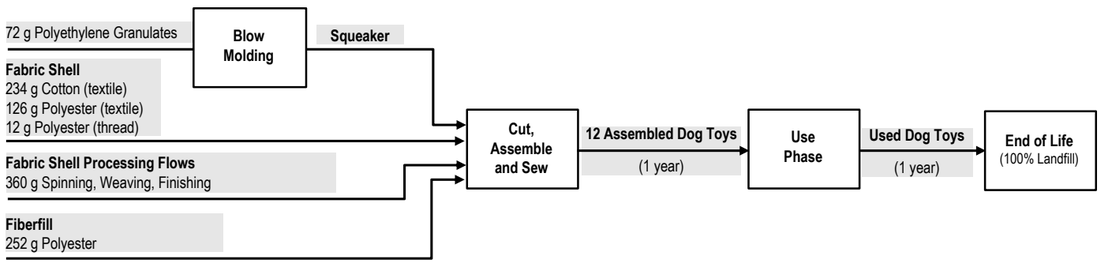
Assumptions and estimations are outlined below:

1. The baseline toy lasts for one month (from accumulated online reviews)
2. The weight of the thread of the baseline toy
3. The amount of time it takes to sew and cut the baseline toy (measured by linear inches)
4. The impact from electricity measured by linear inches x kWh/inch (from machine specs)
5. The redesigned toy lasts 3x longer than the baseline toy (according to aggregated material data)

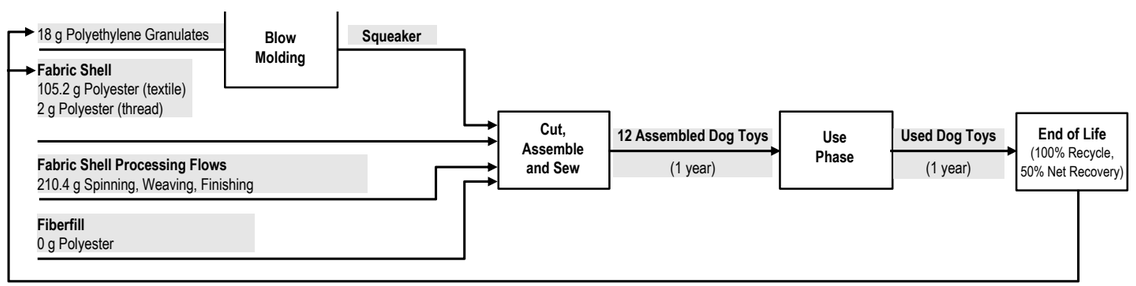
OPENLCA RESULTS

The benefit of using openLCA is that it already captures every process behind the material component. For example, openLCA has an input flow of non-woven polyester textile. Therefore, the extraction of raw material, spinning, weaving, and dyeing is already accounted for in the input flow and can immediately jump to the cut, sew, and assembly of the dog toys in the process flow diagram. However, while setting up the rest of the input and output flows in openLCA, it was realized that there were no forms of recycled polyester or recycled water bottles as options. To account for a recycled material being recycled again, the weights of the squeaker and fabric were divided by two to represent 50% net recovery. This decision was made because there are still impacts from the recycling process itself and yields a more conservative result. The electricity impacts from sewing calculate from the machine specs for a Gerber Industrial Cutting Machine. It produces 0.013kWh of electricity per inch. Therefore, by multiplying by the linear inches on the toy, the total impact from electricity is calculated in openLCA. In addition, the calculation ran in terms of 1000 functional units to yield higher numbers. The raw data is in Appendix F.

BASELINE TOY



REDESIGNED TOY



x1.8 ACIDIFICATION

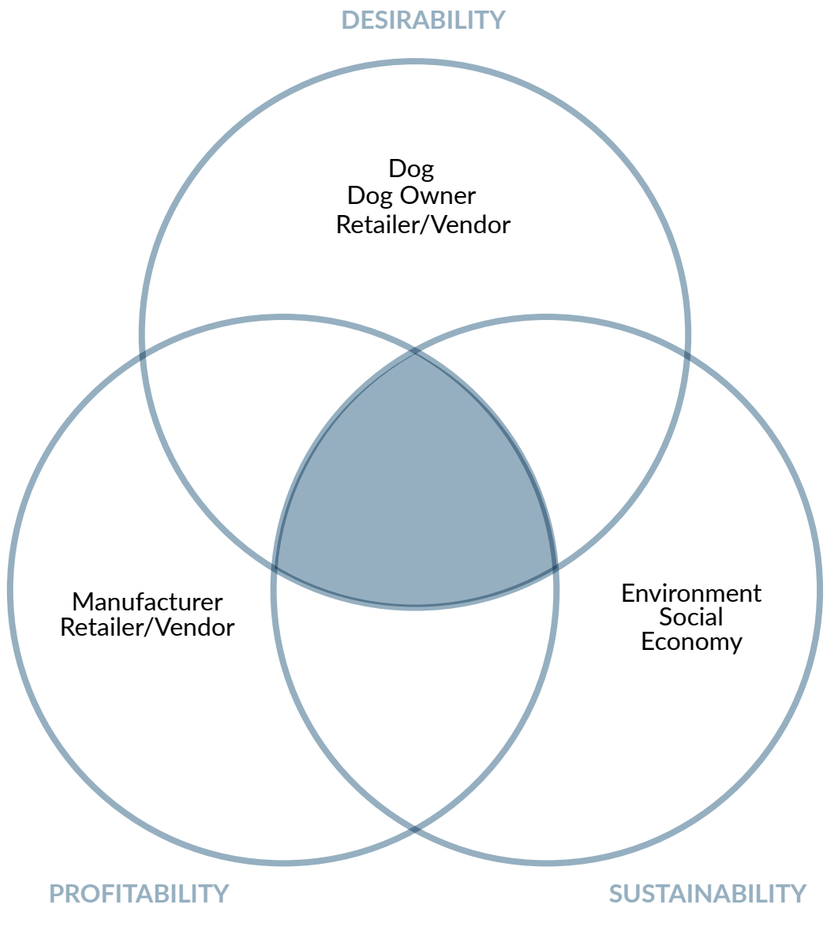
x1.6 GWP & HUMAN TOXICITY

x2.3 EUTROPHICATION

The results above show that the baseline toy has an overall higher environmental impact versus the redesigned toy. From the five impact categories: acidification, global warming potential (GWP) and human toxicity, and eutrophication, the baseline toy's results were approximately x1.8, x1.6, and x2.3 the impact amounts of the baseline toy, respectively. Impact categories are used in life cycle assessments to group different emissions into one effect on the environment. Acidification indicators pollute soils and water due to the release of gases, such as nitrogen oxides and sulfur oxides. Eutrophication is an indicator of the enrichment of the aquatic ecosystem with nutritional elements due to the emission of nitrogen or phosphor-containing compounds. GWP is an indicator of potential global warming due to emissions of greenhouse gases to the air (which is the most commonly used). Human toxicity is the impact on humans of toxic substances emitted to the environment. Overall, the redesigned toy is not only 3x more durable than the baseline toy, but it also has about 2x less of an impact on the environment in terms of the chosen impact categories.

CONCLUSION

In conclusion, the redesigned doy had a lower environmental impact, and 100% of dog owners agreed they would be willing to buy it. Therefore, the results show that a more sustainable dog toy can be made where dog owners are still willing to purchase. Even though the shipping method was unable to be tested through USPS, 100% of dog owners still said the concept was their favorite aspect of the toy. Therefore, it gives a high confidence value to the overall idea. In summary, by looking back at the design criteria and triple Venn diagrams, the project outcome can be deemed successful in all three areas of desirability, sustainability, and profitability. Desirability: 100% of dog owners said they would want to buy the toy. Profitability: On average, dog owners were willing to pay $17.99 for the toy, which would still incorporate a suitable profit margin when including more expensive materials. Sustainability: Environment (diverts toys from the landfills, uses recycled and upcycled materials, and has a lower environmental impact from the LCA), social (encourages recycling, reduces dog's separation anxiety, ability to make an impact from home), and economy (sustainable business model, single material = less cost = better profit).



DESIGN CRITERIA MET

Below, all aspects of the design criteria were met (see underlined), except for the non-essential. A "timeless aesthetic" and "fostering an emotional connection to the product" were not met because they are indeterminable unless they went to market. For a product to be "timeless," it needs to show that its design and aesthetic can last over many years and doesn't get "outdated." In addition, "fostering an emotional connection to a product" requires an interaction where it induces a positive memory or feeling. These were not necessarily measurable within the scope of this project.

MUST HAVE

Recyclable
Made from single material
Durable
Cute and/or funny
Within price range
Effective and efficient communication
Solves consumer need or problem
Targets all 3 pillars of sustainability

SHOULD HAVE

Made from sustainable materials
Less complex and simple design
Encourage low consumption behaviors

NICE TO HAVE

Timeless aesthetic
Foster emotional connection to product

DISCUSSION

CONSTRAINTS & LIMITATIONS

Due to COVID-19, USPS was not accepting sample packages through their engineering department for testing. Therefore, I had to mock up several sample tests to determine the likelihood of this passing through USPS's machines (scannability through QR code and fitting dimensions).

Due to time constraints, I did not gain approval from the IACUC to conduct tests with the dog owner's dogs. Therefore, I had to determine toy durability by the owner's perception and calculations of its material tensile strength and GSM by combing several datasets found on the internet.

To answer my research question, I had to determine "if their dog would like it" and "willingness to purchase" by owner perception. Most dog owners answered these questions confidently based upon previous knowledge and history of dog toys bought in the past except for durability. Too many variables can determine its durability (toy construction, type of material, type of play). Therefore, dog owners were hesitant to give a confident answer. To yield better results, I desire to sell a small sample of these toys on Etsy, Shopify, or Amazon to quantify desirability by the units that sell.

The prototype was made from 100% woven and twill cotton canvas due to lengthy shipping times to receive rPET canvas materials. 100% cotton canvas was the next best alternative found at craft stores like Hobby Lobby and Joann's Fabrics. The threads used were a mixture of polyester and cotton. Overall, since the prototypes did not get tested with dogs, materials used what was available and on hand. In addition, the BRM label was placed on the fabric using an iron-on sheet transfer. In reality, I would want the label stamped on using natural dyes or inks to avoid a plastic film layer. The squeaker I would also desire to be made out of 100% rPET.

WHAT WAS LEARNED

I never realized how much the aesthetics or the "cute" factor played a role in dog toy design. After many conversations with Jeff Watson (Director of Product Engineering from PetSmart) and several dog owners, it seemed as if owners were willing to pay for anything. If it drew their attention and it was so cute or funny, they had to buy it. Impulse buys were very common amongst dog owners.

Starting this project, I was intimidated because I have never worked in soft goods design. I had never used a sewing machine before this and only knew the general principles behind hand sewing. Sewing is an art in itself, and I hope to get better at it over time.

I was pretty shocked to see that dog owners were "sold" when they saw the BRM label rather than the separation anxiety aspect. Because throughout my research, I found that many dogs have separation anxiety. But as soon as they saw how convenient it was to recycle the toy, they loved the idea. Additionally, because it was new, and never seen anything like it before.

NEXT STEPS

1. Contact USPS to get a sample tested by their engineering department for scannability of the fabric and if it meets all standards and requirements for Business Reply Mail (BRM)

2. Test with dogs to determine their durability over the course of a few days or weeks

3. Gather and construct toy out of actual materials desired:
- 100% rPET thread (sewing construction)
- 100% rPET canvas (body of toy)
- 100% rPET (squeakers)
- azo free or natural dyes/inks (BRM label stamp)

4. Contact or visit textile recycling facilities with the prototype to see if the toy could be recycled there (saliva, rips, etc.). If not, what would need to be changed?

5. Find a professional seamstress to construct the toy for maximum durability (seam strength, choice of threads, type of stitching, etc.) and the closest aesthetic to the final product

6. Develop packaging, branding, and marketing of the product to make it "shelf-ready."

7. Sell a small sample of the final toy prototype through e-commerce platforms to quantify desirability and "willingness to purchase."

8. Ideate on different concepts for "legs" of the toy since a few dog owners wanted to use it to play tug of war with their dogs (ex: made out of braided upcycled t-shirts, braided rope, etc.).

9. Find a more efficient cutting layout to minimize the amount of scrap leftover

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APPENDIX A

ONLINE SURVEY

Introduction

Sustainable Choices & Purchasing Survey for Dog Owners

My name is Cheyenne Raker and I am a current graduate student studying Industrial Design at the Georgia Institute of Technology. You are being asked to be a volunteer in a research study. The purpose of this study is to gather insights for my current thesis question to understand what motivates or inhibits sustainable choices for dog owners (as experts).

The online survey will take approximately **5 minutes** to complete.

Your responses will be kept completely confidential. Your answers will be completely anonymous and any demographic information will not be linked to your email address, if you choose to provide at the end of the study.

The risks involved are no greater than those involved in daily activities. You will not benefit or be compensated for joining this study. We will comply with any applicable laws and regulations regarding confidentiality. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records. The Office of Human Research Protections may also look at study records. If you have any questions about the study, you may contact the PI (Kevin Shankwiler) at kshankwiler@gatech.edu or Co-PI (Cheyenne Raker) at craker3@gatech.edu. If you have any questions about your rights as a research subject, you may contact Ms. Melanie Clark, Georgia Institute of Technology at (404) 894-6942.

Thank you for participating in this study.

If you do not currently OWN a dog, please kindly end or exit this survey. Even if you currently take care of dogs, or have owned a dog in the past, this survey is specifically targeted towards current dog owners.

By clicking the button below, you acknowledge:

- Your participation in the survey is voluntary.
- You are 18 years of age.
- You are aware that you may choose to terminate your participation at any time for any reason
- By completing the online survey, you indicate your consent to be in the study

I consent, begin the study
I do not consent, I do not wish to participate

U.S.

Do you currently reside in the U.S.?

Yes
No

Pet ownership

Dog Ownership

Do you **currently own** a dog?

Yes
No

Pet Ownership (cont'd)

Dog Ownership

How many **dogs** do you currently own?

1
2

APPENDIX A

ONLINE SURVEY

3 - 5

More than 5

Dog Ownership - Product Purchases

On the following questions, please rank by importance, with 1 being the most important and 7 being the least important. (Select by dragging and dropping)

What factors are most important to you when buying **non-food related** products for your dog(s)?

Environmentally friendly/green products

Health

Durability

Price

Quality

Safety

Other (please specify)

What factors influence the **non-food related** products you buy for your dog(s)?

"Will my dog(s) like it"

Philanthropic brands (ex: % of purchase goes toward humane societies, ASPCA)

Health endorsements (FDA approved, latex free, etc.)

Made in USA

Recommendations/reviews by other pet owners

Aesthetics (packaging, cuteness, etc.)

Other (please specify or write "none")

Sustainability habits

Sustainability - Products & Lifestyle

A truly sustainable product is one that is made with

- responsible materials (eco-friendly and green)
- produced in an ethical way (fair trade)
- has an efficient life cycle
- can be disposed of with minimal impact (there must be no permanent damage to the environment, from the extraction of the raw materials to the disposal of the final product)

Please answer the following questions on a scale from 1 to 5, with 1 being not important and 5 being extremely important.

In general, how important is it to you to minimize your impact on the environment?

5 - Extremely Important

4

3 - Neutral

2

1 - Not Important

How important is sustainability to you when it comes to making **non-food related** product purchases for your dog(s)?

5 - Extremely Important

4

3 - Neutral

2

1 - Not Important

APPENDIX A

ONLINE SURVEY

Sustainability - Purchases

Are you more likely to purchase a **non-food related** pet product with at least one of these labels?

Yes

No

I do not recognize any of these labels

For which characteristics of sustainable (non-food related) pet products would you be willing to pay a premium for? (Check all that apply)

Biodegradable/compostable

Made in USA

Zero waste

Recycled and/or sustainable materials (ex: made from recycled plastic water bottles)

Plastic free

Reusability (recyclable, take-back programs, multiple use, etc.)

% of purchase goes toward sustainable causes

BPA free (free of chemicals)

Fair trade practices

Organic and/or natural materials (bamboo, plant-based, etc.)

Other (please specify)

I would not pay a premium for a more sustainable product

Sustainability - Purchases

Below are two different types of dog bone chew toys.

Left Toy

- made from a floatable Zogoflex material that is latex, BPA, and phthalate free, non-toxic, and FDA-compliant (safe to eat off of)
- dishwasher safe
- made in the USA
- made from a Thermoplastic Elastomer (TPE) material that is extremely durable and elastic (can stretch 400 x it's length)
- can continue to be recycled without compromising the products integrity through the manufacturer's closed-loop recycling program
- Certified B corporation (where they are legally required to consider the impact of their decisions on their workers, customers, suppliers, community, and the environment)

Right Toy

- made from a floatable and durable rubber that is non-toxic, BPA and phthalate free, and FDA-compliant (safe to eat off of)
- easy to clean
- made in China
- eco-friendly and 100% recyclable
- action cleaning nubs help clean teeth, reduce tartar, control plaque, and massage gums

The **left** toy is priced at **$15.95,** while the **right** toy is priced at **$13.59.**

APPENDIX A

ONLINE SURVEY

According to the description above, which toy are you more likely to purchase?

The left toy ($15.95)
The right toy ($13.59)
Neither

In a few sentences, please explain why you chose "neither"

What factors influenced your purchase decision? (Check all that apply)

Non-toxic
BPA free (free of chemicals)
Price
Reusability (recyclable, take-back programs, multiple use, etc.)
Fair trade practices
"Will my dog(s) like it"
Aesthetic/cuteness
Made in USA

Dental health
Sustainable & environmentally friendly
Durability
FDA compliant
Zero waste
Other (please specify)

Demographics

Demographics

What is your age?

Under 24
24 - 39
40 - 55
56 - 74
74+

What is your gender?

Male
Female
Other (please specify)
Prefer not to answer

What is your ethnicity?

White
Hispanic or Latino
Black or African American
Native American or American Indian
Asian/Pacific Islander

APPENDIX A

ONLINE SURVEY

Other (please specify)

What is your current employment status?

Employed full time
Employed part time
Unemployed
Retired
Student
Disabled

Are you married?

Yes
No
Prefer not to answer

What is your combined annual household income?

Less than $25,000
$25-000 - $49,999
$50,000 - $99,999
$100,000 - $199,999
More than $200,000
Prefer not to answer

How many children do you currently have in the household?

0
1
2-4
More than 4
Prefer not to answer

End of Survey

Do you have any other comments you would like for us to know about?

Powered by Qualtrics

APPENDIX B

ONLINE INTERVIEW SCRIPT

What questions do you want to ask? (interview guide/protocol)

1. Thank them for volunteering to participate and introduce myself
    a. Do you have any questions before we begin?
2. Explain purpose of the interview
    a. The purpose of this interview is to gain insights into what drives consumers to purchase specific dog toys and how sustainability could affect their decisions.
3. Address terms of confidentiality
    a. Your comments and video-recorded interview will be kept by the interviewer and will not be distributed elsewhere. Your demographic information linking to your name will be completely confidential and will not be exposed to the public. Only your answers will be generally used to develop insights of what drives purchasing decisions of dog toys specifically in dog owners.
4. Explain format of semi-structured interview
    a. The interview should take no longer than one hour.
    b. The interview will start by the interviewer asking brief questions, asking about your dog(s) and general experiences you've had with your dog.
    c. Follow up questions will then be asked addressing what types of toys you buy for your dog, shopping habits, and more specific questions in regard to sustainability.
    d. After 1 hour, the interview will conclude and the interviewer will tell the participant how to get in touch with the researchers if they have any further questions
5. List of questions to ask
    a. Begin with facts (general conversation):
        i. How many dogs do you have?
        ii. What type of dog are they?
        iii. How old are they?
        iv. How long have you had them for?
        v. What kind of relationship do you have with your dog? (best friend, ESA, keeps me active, keeps me company, etc.) or WHY did you get a dog in the first place??
    b. Shopping habits for toys
        i. Do you buy toys for your dog? If not, why?
            - What types of toys do you typically buy for your dog? Why?
                a. Do you buy plush toys? Rubber toys? What about them do you like or not like?
                b. How often do you buy plush toys vs rubber/chew toys?
            - How do your dogs play with the toys?
        ii. When looking to make a decision for a toy purchase, what are your top priorities when choosing?
            - How would you describe the quality of the toys that you buy?
            - How long do they typically last? What do you do with them afterwards?
            - How do you know what type of toy your dog likes?
        iii. How do you introduce toys to your dog?
        iv. Describe a typical shopping experience when buying for your dog.
            - Could you describe what is your typical price range when purchasing dog toys? Explain more if needed.
            - Where do you currently shop for your dog? (stores, or in-person vs online) Why?
                a. What are the pros and cons of shopping at those stores?
                b. Is there anything you would want to change about that store to make it better?
        v. In general, what type of toy do you want to see? Or what do you want to see changed in current toys you find? AKA If you could have your ideal toy, what would you want and why would you buy it?
            - Do you do anything with the toys to clean them?
            - What is your dogs current favorite toy?
            - Are there specific type of toys you buy for a reason? Do they have anxiety? To calm them down? Etc?
    c. Sustainability
        i. On a scale from 1-10, how much do you know about sustainability and/or sustainable products? Why?
        ii. What is your own definition of sustainability? What does it mean to you?
        iii. When you see a dog toy marketed as sustainable or eco-friendly/green, what first comes to mind?" (Do you believe their labeling?) or how would you describe your reaction when you see these types of toys?
        iv. Do you currently buy sustainable/eco-friendly dog toys? Why or why not? If not, do you buy other sustainable items (non-dog toy related)?
        v. Would your perception of the stores you shop at for your dog change if they offered more sustainable dog toys?
            - How would it change?
        vi. What would change your purchasing habits in the future to be more sustainably conscious when buying dog toys? (Clearer labeling, more information…more of a conversation).
    d. Are there any other comments you would like to add?
        i. <u>Could you describe your ideal dog toy??</u>
    e. Explain the purpose of the intended study –How the design of a dog toy could be improved or redesigned so that owners can be more sustainably conscious but where consumers are still willing to purchase.

APPENDIX C

PROTOTYPE EVALUATION GUIDE & ASSESSMENT

What questions do you want to ask? (interview guide/protocol)

1. Thank them for volunteering to participate and introduce myself
    a. Do you have any questions before we begin?
2. Explain purpose of the study
    a. The purpose of this study is to determine if the proposed prototype is desirable to dog and dog owners through an evaluation assessment and if any changes need to be made to better meet those desires. Desirability will be defined as aesthetically pleasing, easy to use, easy to understand, good price point, sustainable/good for the environment, durable, and if their dog would like it.
3. Address terms of confidentiality
    a. Your comments and video-recorded interview will be kept by the interviewer and will not be distributed elsewhere. Your demographic information linking to your name will be completely confidential and will not be exposed to the public. Only your answers will be generally used to further develop the prototype into a desirable dog toy.
4. Explain format of evaluation assessment
    a. The assessment should take no longer than one hour.
    b. The evaluation assessment will start by the interviewer explaining how the prototype works (briefly) then asking the dog owner to have the prototype on hand (if not already).
    c. The evaluation assessment will then begin.
5. Evaluation Assessment (Likert Scale) w/ Follow up Questions

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I found this toy difficult to use					
I think this toy would be safe for my dog					
I don't think my dog would like this toy					
I would buy this toy for my dog					
Being able to recycle the toy does not interest me					
The method for shipping the toy seems convenient					
I don't think this dog toy would be durable enough for my dog					
I would recommend this toy to a friend or family member					
I found the toy to be aesthetically unappealing					

    a. What were your initial reactions when you opened the box?
    b. How did the overall study go? Did you notice any different types of reactions with your dog?
    c. At what price point would you be willing to pay for this type of toy, or expect to pay?
    d. What aspects of the toy did you like the best? The least?
    e. Did your dog seem to enjoy the toy?
    f. What aspects of the toy were the most difficult to do or understand? The least?
    g. Any other considerations or improvements you would like to see for the prototype?
    h. Any additional comments?

Results from Dog Owners Responses

	Dog Owner 1	Dog Owner 2	Dog Owner 3	Dog Owner 4	Dog Owner 5	Dog Owner 6	Dog Owner 7
Q1	1	2	2	1	2	1	1
Q2	4	5	5	5	5	5	4
Q3	2	1	2	3	2	1	1
Q4	4	5	5	5	3	5	5
Q5	3	1	1	1	2	2	1
Q6	5	5	5	5	5	5	5
Q7	4	3	1	1	1	2	3
Q8	4	5	5	5	3	5	4

APPENDIX D

OKALA IMPACT FACTORS ANALYSIS

Follow link below for full analysis of calculations and results:

https://drive.google.com/file/d/1SCZ-VqM9uWYfuqqex8sLFsJNJtv49WLM/view?usp=sharing

APPENDIX E

CALCULATING DURABILITY

Fabric GSM Chart

Category	Ounces per square inch	GSM	Thread	Fabric
Extra Light	2 - 4	8 - 136	80WT - 60WT	Wadding, hollow fiber fabric, voile, chiffon
Light	4 - 6	136 - 204	60WT - 50WT	Lightweight cotton, PVC metting
Medium	6 - 8	204 - 272	50WT - 40WT	Quilted waterproof fabric
Medium Light	8 - 10	272 - 339	50WT - 40WT	Jute cloth, hessian fabric, stretch denim
Heavy	10 - 12	339 - 407	40WT - 30WT	Rigid denim, canvas, wool
Extra Heavy	12 - 14	407 - 475	30WT - 20WT	Denim fabric, coating

Okala Impact Factors of Textiles

Material	Impact Factor Points
Bamboo	0.007/lb
rPET	1.6/lb
PET	1.8/lb
Jute	2.5/lb
Hemp	2.9/lb
Linen	3.1/lb
Rayon	4.1/lb
Nylon	11/lb
Organic Cotton	15/lb
Wool	18/lb

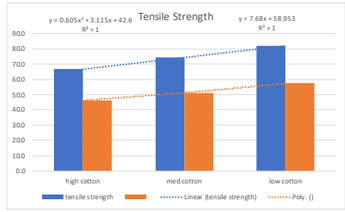
Article 3 Calculations

Material composition					Warp	Weft	Ends per inch	Picks per inch	Warp	Weft	Warp	Weft
Cotton	Polyester	Ref #	Weave Patte	GSM	Yarn Count		Thread Density		Tensile Strength		Tear Strength	
85	15	3	3:1	295	7 Ne	6 Ne	82	66	76.21kg	41.56kg	5.978kg	4.133kg
80	20	1	3:1	380	10 Ne	8 Ne	78	60	66.62kg	46.32kg	6.79kg	4.28kg
75	25	3	3:1	295	7 Ne	6 Ne	82	66	88.46kg	53.42kg	7.492kg	5.312kg
70	30	1	3:1	380	10 Ne	8 Ne	78	60	74.34kg	51.25kg	8.18kg	6.13kg
65	35	3	3:1	295	7 Ne	6 Ne	82	66	99.34kg	66.11kg	9.862kg	6.588kg
60	40	1	3:1	380	10 Ne	8 Ne	78	60	81.98kg	57.39kg	10.08kg	8.02kg

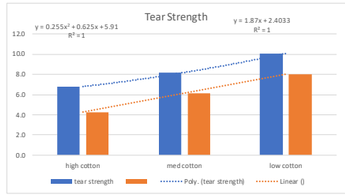
		warp	weft	warp	weft
cotton	poly	tensile strength		tear strength	
80	20	66.6	46.3	6.8	4.3
70	30	74.3	51.3	8.2	6.1
60	40	82.0	57.4	10.1	8.0
50	50	89.7	64.7	12.49	9.9
40	60	97.4	73.3	15.41	11.8
30	70	105.0	83.1	18.84	13.6
20	80	112.7	94.1	22.78	15.5
10	90	120.4	106.2	27.23	17.4
0	100	128.1	119.6	32.19	19.2

1.56225096 2.08468374 3.19345238 2.39816708 **Strength Multipliers**

1.82 2.80 **Average of Strength Multipliers**



warp	weft	warp	weft
x	y	x	y
0	59.0	0	42.6
1	66.6	1	46.32
2	74.3	2	51.25
3	82.0	3	57.39
4	89.7	4	64.74
5	97.4	5	73.3
6	105.0	6	83.07
7	112.7	7	94.05
8	120.4	8	106.24
9	128.1	9	119.64
10	135.8	10	134.25



warp	weft	warp	weft
x	y	x	y
0	5.9	0	2.4
1	6.8	1	4.3
2	8.2	2	6.1
3	10.1	3	8.0
4	12.5	4	9.9
5	15.4	5	11.8
6	18.8	6	13.6
7	22.8	7	15.5
8	27.2	8	17.4
9	32.2	9	19.2
10	37.7	10	21.1

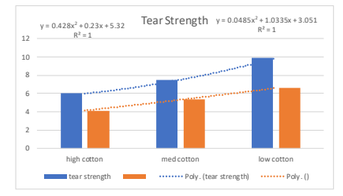
Article 2 Calculations

Material composition					Warp	Weft	Ends per inch	Picks per inch	Warp	Weft	Warp	Weft
Cotton	Polyester	Ref #	Weave Pattern	GSM	Yarn Count		Thread Density		Tensile Strength		Tear Strength	
85	15	3	3:1	295	7 Ne	6 Ne	82	66	76.21kg	41.56kg	5.978kg	4.133kg
80	20	1	3:1	380	10 Ne	8 Ne	78	60	66.62kg	46.32kg	6.79kg	4.28kg
75	25	3	3:1	295	7 Ne	6 Ne	82	66	88.46kg	53.42kg	7.492kg	5.312kg
70	30	1	3:1	380	10 Ne	8 Ne	78	60	74.34kg	51.25kg	8.18kg	6.13kg
65	35	3	3:1	295	7 Ne	6 Ne	82	66	99.34kg	66.11kg	9.862kg	6.588kg
60	40	1	3:1	380	10 Ne	8 Ne	78	60	81.98kg	57.39kg	10.08kg	8.02kg

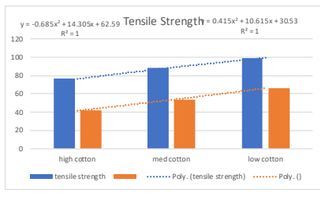
		warp	weft	warp	weft
cotton	poly	tensile strength		tear strength	
85	15	76.21	41.56	5.978	4.133
75	25	88.46	53.42	7.492	5.312
65	35	99.34	66.11	9.862	6.588
55	45	108.85	79.63	13.09	7.96
45	55	116.99	93.98	17.17	9.43
35	65	123.76	109.16	22.11	11.00
25	75	129.16	125.17	27.90	12.66
15	85	133.19	142.01	34.55	14.42
5	95	135.85	159.68	42.06	16.28
-5	105	137.14	178.18	50.42	18.24
0	100	136.495	168.93	46.239	17.2585

1.37401852 2.555286643 4.68860272 2.61968731 **Strength Multipliers**

1.96 3.65 **Average of Strength Multipliers**



warp	weft	warp	weft
x	y	x	y
0	5.32	0	3.051
1	5.978	1	4.133
2	7.492	2	5.312
3	9.862	3	6.588
4	13.088	4	7.961
5	17.17	5	9.431
6	22.108	6	10.998
7	27.902	7	12.662
8	34.552	8	14.423
9	42.058	9	16.281
10	50.42	10	18.236



warp	weft	warp	weft
x	y	x	y
0	62.59	0	30.53
1	76.21	1	41.56
2	88.46	2	53.42
3	99.34	3	66.11
4	108.85	4	79.63
5	116.99	5	93.98
6	123.76	6	109.16
7	129.16	7	125.17
8	133.19	8	142.01
9	135.85	9	159.68
10	137.14	10	178.18

APPENDIX F

OPENLCA DATA & GRAPHS

Baseline Toy

Component	Material	Per Toy	Per Year (12 Toys)	Type of Processing
Squeaker	Polyethylene	6 grams	72 grams	Blow Molding
Fabric Shell	Spun Yarn - 65% cotton, 35% polyester	30 grams	360 grams	Textile Production
	Textile knit cotton	19.5 grams	234 grams	
	Textile polyester	10.5 grams	126 grams	
Fiberfill	Textile polyester	21 grams	252 grams	Garnet Process
Thread	Textile polyester	1 gram	12 grams	None Required
		32.5 grams	390 grams	
Production	Spinning, Weaving, Finishing	30 grams	360 grams	Dying + Processes
Electricity	Electric Power Generation U.S.	1.935 kWh	23.22 kWh	
	90 linear inches of cutting @ 0.013kWh/in.	0.585 kWh	7.02 kWh	Cutting Operation
	45 linear inches of sewing @ 0.03kWh/in.	1.35 kWh	16.2 kWh	Sewing (Electricity)
			696 grams	Total Weight

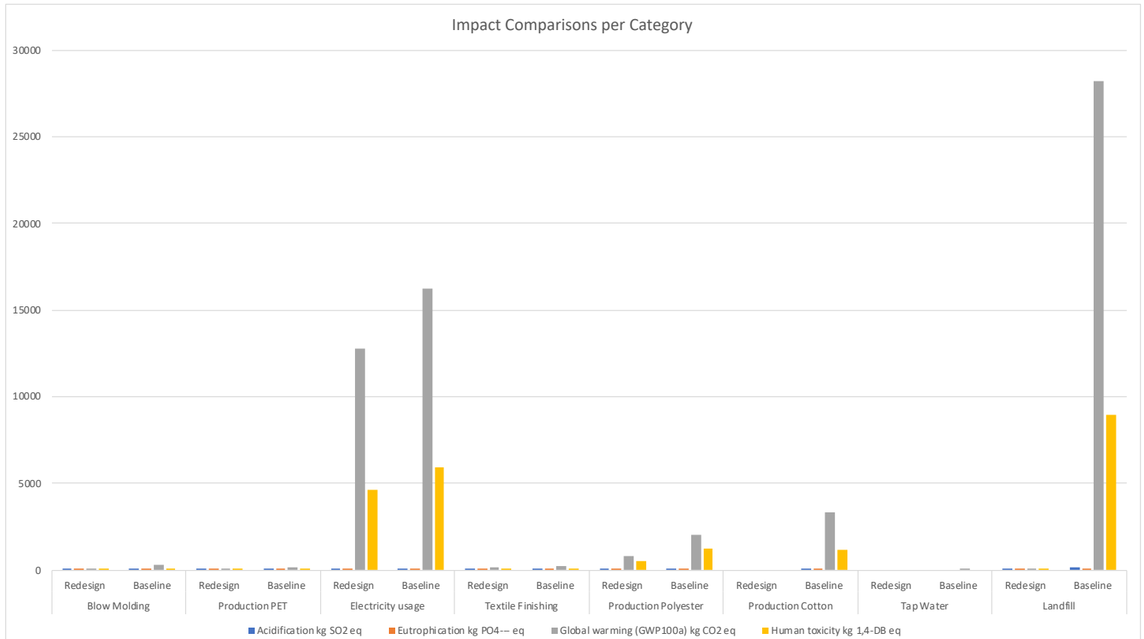
Redesigned Toy

Component	Material	Per Toy	Per Year (4 Toys)	Type of Processing
Squeaker	Polyethylene	9 grams	36 grams	Blow Molding
Fabric Shell	Textile polyester	74.5 grams	298 grams	Textile Production
Fiberfill	NA	0 grams	0 grams	NA
Thread	Textile polyester	2 gram	8 grams	None Required
		2 grams	8 grams	
Production	Spinning, Weaving, Finishing	74.5 grams	298 grams	Dying + Processes
Electricity	Electric Power Generation U.S.	5.97 kWh	23.88 kWh	
	177.5 linear inches of cutting @ 0.013kWh/in	2.31 kWh	9.24 kWh	Cutting Operation
	122 linear inches of sewing @ 0.03kWh/in.	3.66 kWh	14.64 kWh	Sewing (Electricity)
			342 grams	Total Weight

Assumed 50% Net Recycling in LCA Calculation, thus reducing polyethylene input flow to 18 grams
Assumed 50% Net Recycling in LCA Calculation, thus reducing polyester input flow to 153 grams (includes thread content)

openLCA Overall Results

Impact category	Redesign	Baseline
Abiotic depletion kg Sb eq	0.0001752	0.00047949
Abiotic depletion (fossil fuels) MJ	176649.833	284386.791
Acidification kg SO2 eq	56.1527967	98.8950886
Eutrophication kg PO4--- eq	30.1189796	68.3601969
Fresh water aquatic ecotox.	5586.63449	10486.1589
Global warming (GWP100a) kg CO2 eq	13800.4954	22068.3589
Human toxicity kg 1,4-DB eq	5254.12426	8496.51828
Marine aquatic ecotoxicity kg 1,4-DB eq	15046339.7	22559112.7
Ozone layer depletion (ODP) kg CFC-11 eq	0.00279842	0.0058856
Photochemical oxidation kg C2H4 eq	2.68389187	4.16649296
Terrestrial ecotoxicity kg 1,4-DB eq	12.3363087	650.620285



APPENDIX F

OPENLCA RAW DATA (PER CATEGORY)

	Assembly		Blow Molding		Production PET		Electricity usage		Textile Finishing		Production Polyester		Production Cotton		Tap Water		Landfill	
	Redesign	Baseline	Redesign	Baseline	Redesign	Baseline	Redesign	Baseline	Redesign	Baseline	Redesign	Baseline	Redesign	Baseline	Redesign	Baseline	Redesign	Baseline
Abiotic depletion kg Sb eq	0.000175205	0.00047949	1.1279E-06	4.5118E-06	1.0691E-06	4.2764E-06	2.5987E-05	3.3069E-05	2.9984E-06	3.6222E-06	0.00014515	0.00036999	0	6.8533E-05	2.6855E-11	1.0742E-10	4.49763E-07	0.0065452
Abiotic depletion (fossil fuels) MJ	176649.8328	284386.791	1661.42743	6645.70974	1301.54654	5206.18614	158964.532	202285.571	2149.35246	2596.53318	14234.3864	36283.7301	0	38014.7074	0.01567755	0.0627102	322.4028693	284386.791
Acidification kg SO2 eq	56.15279673	98.8950886	0.25841698	1.0336679	0.14131956	0.56527822	51.7235865	65.8193065	1.01166647	1.22214741	3.27621907	8.35114665	0	22.9371892	5.1364E-06	2.0546E-05	0.15174997	130.771633
Eutrophication kg PO4--- eq	30.11897961	68.3601969	0.10162925	0.40651701	0.03732402	0.14929607	28.4041802	36.1448919	0.34304591	0.41441788	1.33442585	3.40147766	0	28.2500989	3.619E-06	1.4476E-05	0.051456886	74.1261795
Fresh water aquatic ecotox.	5586.634485	10486.1589	23.2635058	93.0540231	11.7335704	46.9342814	5092.81293	6480.70712	94.4768156	114.133066	387.610385	988.026472	0	2856.35485	0.00078339	0.00313356	14.17152235	10494.6785
Global warming (GWP100a) kg CO2 eq	13800.49537	22068.3589	71.2549985	285.019994	42.3789072	169.515629	12754.9343	16230.9111	190.687095	230.360249	812.493663	2071.06228	0	3366.50417	0.00136552	0.00546208	28.60306423	28203.05
Human toxicity kg 1,4-DB eq	5254.124261	8496.51828	25.9626201	103.85048	15.4479119	61.7916475	4644.39361	5910.0845	100.496747	121.405466	493.7853	1258.66841	0	1144.56549	0.00069158	0.00276633	15.07451198	8990.75666
Marine aquatic ecotoxicity kg 1,4-DB eq	15046339.69	22559112.7	58893.5527	235574.211	27532.0279	110128.112	13852472.5	17627550.5	265337.636	320542.111	900995.373	2296654.87	0	2204228.44	2.18313993	8.73255973	39800.64542	23239985.8
Ozone layer depletion (ODP) kg CFC-11 eq	0.00279842	0.0058856	3.3064E-06	1.3226E-05	7.1813E-07	2.8725E-06	0.0011433	0.00145488	7.2885E-06	8.8048E-06	0.00164711	0.00419851	0	0.00022053	7.4865E-11	2.9946E-10	1.09327E-06	0.00622608
Photochemical oxidation kg C2H4 eq	2.683891875	4.16649296	0.01801905	0.07207622	0.01250548	0.05002191	2.4354299	3.09913365	0.05653943	0.06830266	0.17941684	0.45733704	0	0.49169678	2.3028E-07	9.2112E-07	0.008480914	2.64669446
Terrestrial ecotoxicity kg 1,4-DB eq	12.33630872	650.620285	0.05051745	0.20206979	0.02730072	0.1092029	10.2540919	13.0485387	0.61875077	0.74748415	1.43616186	3.66080475	0	633.054241	3.4253E-06	1.3701E-05	0.092812615	652.946058

APPENDIX G

LCA PROCESS FLOW DIAGRAM